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Science Education

THE PROBLEM OF SCIENTIFIC TERMINOLOGY IN COURSES DESIGNED FOR GENERAL EDUCATION

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A wide variation exists in introductory textbooks and courses in the biological sciences. The one extreme is represented by the broad, generalized survey courses. The more familiar courses involving considerable morphological study of plant and animal types may be taken as the other extreme. Examination of recently published elementary college textbooks reveals these two extremes and raises many problems which challenge the instructor who earnestly desires to meet the needs of all of his students.

One of these problems concerns the matter of terminology. If we assume that an understanding of life processes is important to all of our students, whatever their major fields of interest and activity may be, we are faced with the problem of terminology. To what extent is the mastery of structure and terminology essential to understanding? In the small part of the student's program of studies that can be devoted to the biological sciences, how much effort should be directed toward the mastery of terminology? May the inclusion of a considerable amount of terminology in general textbooks confuse and hinder the student who attempts to understand the nature of a process? How much of the terminology becomes a workable part of his general knowledge?

In attempting to study this matter, the authors decided to limit this preliminary investigation to the problem of mastering the terminology involved in reproduction and early development in vertebrate animals, especially in man. Examinations of text books in general college biology, other than the survey type, revealed considerable agreement in the terminology introduced. Accordingly, it was decided to utilize one book [1] in the study. A list of one hundred thirty terms, which the investigators thought might prove unfamiliar to students, was selected from the 40 pages of textual material in this book dealing with reproduction. The list was then mimeographed in single column form leaving room for the student to write a definition of each word. Space was also provided for supplying information as to age, sex, year of study, and related science courses pursued in high school and college.

Four groups totaling 103 college students, 38 men and 65 women, who had never been enrolled in college courses in which a study of reproduction was undertaken, were asked to write definitions of the words. They were then given copies of the text and allowed time to read the 40 pages devoted to the subject. They were not told that the test would be repeated, but were urged to try to master the material. After one reading, a second copy of the mimeographed form was distributed and the students were again asked to define the terms. In scoring the papers, only clear, usable definitions were counted

[1] Mavor, James W. *General Biology.*

as correct. Vague and very general answers were scored as wrong.

In addition, the test of ability to define the terms was administered to 37 men and 42 women who had recently completed a course in general biology in which approximately one week was devoted to a study of reproduction. The course was intended for general education, being required of all candidates for the bachelor's degree. Emphasis in the course was on general understanding. The work involved dissection, but no drawings were required and no drill on terminology was employed. Students were supplied with the same textbook that was used with the reading group. The data obtained from both groups are summarized in Tables I, II, III, and IV.

TABLE I

MEAN AND MEDIAN PER CENT OF WORDS CORRECTLY DEFINED

	Reading Group		Class Work Group
	Before reading	Immediately after reading	After participation in brief course
Median	6.2%	13.1%	24.6%
Average	8.0	14.1	25.0

TABLE II

WORDS KNOWN BY NONE OF STUDENTS

Reading Group				Class Work Group	
Before reading		Immediately after reading		After participation in brief course	
No.	Per cent	No.	Per cent	No.	Per cent
48	26.9	18	13.8	17	13.1

The data reveal notable lack of familiarity with the terminology of reproduction. The median number of terms defined correctly by the students before undertaking the reading was only eight. Forty eight of the 130 terms were omitted or incorrectly defined on every paper before reading the chapters. Only three of the

TABLE III

WORDS KNOWN BY LESS THAN TEN PER CENT OF STUDENTS

Reading Group				Class Work Group	
Before reading		Immediately after reading		After participation in brief course	
No.	Per cent	No.	Per cent	No.	Per cent
97	74.6	76	58.5	50	38.5

TABLE IV

WORDS KNOWN BY MORE THAN FIFTY PER CENT OF STUDENTS

Reading Group				Class Work Group	
Before reading		Immediately after reading		After participation in brief course	
No.	Per cent	No.	Per cent	No.	Per cent
3	2.3	8	6.1	28	21.5

terms were correctly defined by a majority of the students. With due consideration of the limitations of the study, these findings would seem to indicate that, if this group is representative, college students are surprisingly unfamiliar with the terminology of reproduction, despite the wide and general interest which this life process commands.

Reading the textual material approximately doubled the scores. The scores of the group having had brief classwork on reproduction were three to four times as high as those made by the control group. While these scores probably represent significant gains, they evidence only very limited achievements in mastering the terminology of reproduction. The average student could define only about one-seventh of the terms after reading and

only one-fourth of the terms after classwork. Only 6.1 per cent of the terms were correctly defined by the majority of the students after reading the material and only 21.5 per cent of the terms after the classwork. Nearly one-seventh of the terms remained unmastered by even a single student.

TABLE V

TERMS MOST EASILY MASTERED BY STUDENTS

Term	Per cent correct before reading	Per cent correct after reading	Per cent correct after classwork
fertilization	73.8	79.6	93.8
embryo	42.7	70.9	77.5
testes	21.4	54.4	87.5
dorsal	35.9	52.4	85.0
pituitary	69.3	58.3	78.8
ovary	37.9	59.2	76.3
oviduct	24.2	48.5	85.0
umbilical cord	15.5	40.7	86.3
foetus	16.5	55.3	68.8
nucleus	66.0	46.6	67.5
afterbirth	23.3	48.5	63.8
metamorphosis	50.5	55.3	56.3
ciliated	30.0	31.1	75.0
ventral	31.1	36.9	68.5
ovulation	9.7	42.7	57.5
chromosome	27.1	17.5	75.0
Fallopian tubes	4.8	26.2	65.0
puberty	12.6	33.0	57.5
endocrine	30.0	24.2	65.0
placenta	4.8	23.3	62.5
coelenterate	40.7	36.9	48.8
tympanum	27.1	33.0	52.5
spermatazoa	10.7	31.1	53.8
vertebral	37.9	33.0	51.3
sclerotic	32.0	37.9	46.3
scrotum	7.9	34.9	43.7
semen	12.6	32.0	43.7
copulation	4.8	37.9	48.8
mitotic	7.7	6.8	66.3
Eustachian tube	24.2	26.2	46.3
ovum	19.4	26.2	42.5
hormone	13.6	15.5	58.8

The great difficulty which some of the terms seemed to present and the relative ease with which certain others were mastered prompted a comparison. In Tables V and VI are presented summations of the scores of the three groups on the words in the highest and lowest quartiles when the terms were arranged in order of evident difficulty.

A large percentage of the terms that were correctly defined by scarcely any of the students are concerned with tissue differentiation in the developing embryo and foetus. It would seem that, in the interest of simplicity and general understanding, many of them might well be omitted from elementary college textbooks of general biology.

TABLE VI

TERMS WITH WHICH STUDENTS HAD MOST DIFFICULTY

Term	Per cent correct before reading	Per cent correct after reading	Per cent correct after classwork
cervix	1.9	7.7	1.3
yolk plug	0.0	5.8	3.8
hyoid	4.8	.9	5.3
seminiferous tubules	0.0	4.8	3.8
mesonephros	0.0	1.9	5.0
vitelline membrane	0.0	4.8	1.3
mesorchium	0.0	4.8	0.0
Zona pellucida	0.0	3.9	1.3
vasa efferentia	0.0	0.0	3.8
chalaza	0.0	2.9	0.0
blastodisc	0.0	0.0	2.5
allantois	0.9	1.9	0.0
endolymph	0.9	1.9	0.0
Eutherian	0.0	1.9	0.0
inguinal canals	0.0	1.9	0.0
mesoblastic	0.0	1.9	0.0
sagittal	1.9	0.0	0.0
chorion	0.0	0.9	1.3
neural crest	0.0	0.9	1.3
neurenteric canal	0.0	0.9	1.3
glomerules	0.0	0.0	1.3
infundibulum	0.0	0.0	1.3
nephrostome	0.0	0.0	1.3
somites	0.0	0.0	1.3
hyomandibular	0.9	0.0	0.0
meroblastic	0.0	0.0	0.0
mesenchyme	0.0	0.0	0.0
myotomes	0.0	0.0	0.0
placode	0.0	0.0	0.0
proctodaeum	0.0	0.0	0.0
splanchnic	0.0	0.0	0.0
stomadaeum	0.0	0.0	0.0

Most of the terms that were correctly defined by most of the students are either essential to an elementary understanding of reproduction or of wider interest and application, as "dorsal" and "ciliated."

In order to discover whether any sex differences in problems of mastery of the terminology were evidenced, the scores of the men were compared with those of the women on terms grouped on the basis of whether they pertained to the separate sexes or were mutually applicable. Three such sets of terms were selected for comparison. The average scores for both men and women are shown in Table VII.

TABLE VII

SEX DIFFERENCES IN THE MASTERY OF TERMINOLOGY

	Average scores of men			Average scores of women		
Terms pertaining to:	Before reading	After reading	After course	Before reading	After reading	After course
Female	11.4%	24.0%	41.1%	9.7%	23.2%	41.5%
Male	7.5%	19.5%	29.0%	2.3%	11.7%	19.7%
Both sexes	12.5%	30.1%	47.9%	13.2%	25.9%	53.4%

In the mastery of the general terminology pertaining to both sexes and that pertaining to the female, no significant differences between the scores of men and women are evident from the data. The data do seem to indicate that the women were considerably more unfamiliar with the reproductive terminology of the male than were the men. The differences were maintained consistently in the scores before reading and in the gains after reading and after class work. Even the men learned the terminology of the female reproductive system and that applying to both sexes better than they did their own.

The preliminary nature of this study does not warrant advancing any solutions to the problems of scientific terminology in courses designed for general education. It does, perhaps, tend to emphasize the great difficulty which many of the terms present to the general student. It would be even more important to discover how much the inclusion of excessive terminology hinders general students in acquiring an elementary understanding of life processes.

Some mastery of the terminology of a life process such as reproduction would seem to be highly important, just how much we do not know. While the data are very limited, they suggest that this need has not been met by the time the students reach college age. They also show that the terminology presents real difficulties for the college students. College instructors may find it necessary to provide much more concrete experience basis to enable students to read college textbooks effectively. Writers of textbooks for the general student might do well to give more consideration to the difficulties which scientific terminology presents. Perhaps graded reading series for the college level are needed.

AN EXPERIMENT TO SHOW THE EFFECTS OF NOISE

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In October, 1938, an experiment, designed to make clear to a group of 11th and 12th grade high school students at the Lincoln School the effects of working under noisy conditions, was performed. No claim is advanced either for the striking originality of the experiment or for the sweeping quality of any conclusions that may be drawn from it. However it is felt that the outcomes in terms of the putative changes in the attitudes and appreciations of the students themselves were sufficiently important to warrant describing the experiment, and its background, in print.

Volunteers from two classes in physical science took two equivalent forms of the Otis Self-Administering Test of Mental Ability, Higher Examination. One form was given under normal classroom conditions. The second form was given under conditions of rather horrible noise. Using a powerful amplifier, sounds from two sources were blended—one a turntable playing dance tunes, the other a photoelectric cell (actually a Weston photronic cell). Onto this cell there fell a concentrated beam of light which had passed through the most irregularly spaced row of holes on a rotating siren disk. The two sounds were, then, blaring phonograph music and a noise which sounded very much like a loud airplane engine. The mixture of the sounds was not held constant in volume but was varied rather widely during the 20 minutes during which the test was run. Sometimes the two would be mixed in approximately equal volumes so that neither was dominant, again the phonograph would predominate, or the noise. Pitches of both the music and the noise would be changed. Occasionally, for greater distraction, both sounds would be turned off completely for a few seconds. No instrument was at hand to measure the loudness of the sounds in the room. However, on one previous occasion the loudness under similar conditions had been measured and a value in excess of 90 decibels obtained—a sound louder by quite a bit than a lion roaring at a distance of 18 feet, louder than the noisiest spot at Niagara Falls and about equal to a steamship siren at a distance of 115 feet.[1] The students had been warned in advance that the noise would be rather unpleasant. In spite of this fact the majority of the two classes came for the test given under noisy conditions—a test which, for obvious reasons, had to be given after school hours. Those not participating were, in every case, absent because of other appointments which had a prior claim rather than from choice.

At the Lincoln School the usual courses in physics and chemistry have been replaced by a two-year sequence. Space does not permit a description of that sequence other than that it constitutes a synthesis of materials from chemistry, physics, geology, astronomy, and from other fields in lesser degree, organized about 15 units. The order of the units in the two years, and the character of the units themselves, can be changed to meet the exigencies of the situation in any given year and with any given class. During the present year, it seemed desirable to teach those units dealing with materials

[1] Numerous reports of loudness levels, in decibels, of certain sounds have been published in recent years. The figures used here were taken from the summary given by G. W. C. Kaye in his article "The Measurement of Noise." Smithsonian Institution Report for 1932, p. 185–6.

that are taken most closely from traditional physics. The first unit was one which dealt with sound—an energy form directly used by man. This unit differs considerably from the traditional treatment accorded the subject in physics texts. Let us digress briefly to give the bases for that divergence.

It is not hard to find justification for the position that science teachers should continually strive to show the social implications of their material. Dewey takes this position [1] and the emphasis on social sensitivity made by the P.E.A. Commission on Secondary Curriculum in its recent report [2] is in agreement. Acceptance of this point-of-view lead to the inclusion in the unit of such material as that dealing with the social effects of noise and the responsibility of each person in connection with noise reduction.

Probably both philosophical and psychological in character is the insistence that the subject-matter be closely related to the student himself,—that in recognition of the egoist in us all, emphasis be continually placed upon the effects of the science phenomena upon the students as individuals. Hence such material as the emotional effects of loud noises, the physiology and psychology of hearing, the question of how the voice is produced and how each student's speaking voice might be improved were included.

Previous to the experiment, then, the students had read rather widely from such articles and books as that by Kaye (previously referred to), from the Noise Abatement Commission Report, and from some of the other sources given at the end of the article. Discussions and experiments followed. Every effort was made to bring home to the students the emotional effects of noise as, for example, when a phonograph, softly playing, was without announcement or explanation suddenly turned loud. Each student was asked to analyze his own feelings and the conclusion drawn that, while the feeling of fear, associated with loud noises is probably not innate (despite a wide-spread belief to the contrary) it is nevertheless a common reaction with most people. They also learned of the increases in brain pressure that have been shown to be associated with sudden loud noises (increases greater and more protracted than those produced by shock-inducing drugs), of increased metabolism, of fatigue, of dangers to hearing from noise. Every effort was made to create an appreciative understanding of the background of sound which is the accompaniment of every moment in the life of all save the very deaf, as, for example by the reading and discussion of the article of which the following is an excerpt.

> I blew out my candles late one snowy night and went to bed. The only remaining light was from the flicker of fire showing through the draft of my stove. The flutter of the flame was like a muffled rushing. Slowly, gradually, it died. I dropped off to sleep on a pillow of near silence. I was awakened suddenly by an unusual sound. A shelf of books near my bed had fallen. My mind registered immediately the truth of what had happened, but my body was afraid. No muscle was at normal tension. I was subtly convulsed by the shock which had bred fear.
>
> I said to myself: "You are now afraid. This is fear." Every muscle of my torso seemed to be twisted toward a central point near the solar plexus. The calves of my legs, the long muscles down the front of my thighs, were as though charged with a current of electricity. But while my body was momentarily paralyzed, my mind reasoned quickly. Before the physical reaction faded, the humor of the situation dawned

[1] Dewey, John. "The Challenge to Democracy," *Progressive Education* 14: 79–84; 1937 (Feb.).

[2] Thayer, V. T., and Others. *Science in General Education.*

upon me. A voice inside said, "Run you fool, if you want to. I'm staying here." Of such is fear.[1]

And then, as though we were saying, "We have been talking about the effects of these things long enough. Let us try for ourselves,"—came the experiment. Ideally, the metabolic rate of each person concerned in the experiment should have been taken after a rest period just before the administering of each test, and during the taking of that test. This was impossible. As a possible substitute each person took his own pulse, at the beginning and again at the end of the experiment, averaging a number of trials. However, even these averages were found to be so erratic that this information was valueless and hence is not included in the data. Each person who took the test under noisy conditions was asked to hand in a report in which he told of his sensations during the test and for the balance of the day. Quotations from these reports appear later in this article.

In the table summarizing the data on the two forms of the test, two points need to be made clear. The norms on the Otis Test are based on the results of scores made with a 30-minute time limit. It was desired that no one should have time to check back over his responses since accuracy of response was one of the comparison factors. Hence the students worked for 20 minutes only on the test, their scores being transmuted into terms of the corresponding 30-minute time-limit scores by means of a table given in the test manual.

SUMMARY OF RESULTS OF TESTS UNDER QUIET AND UNDER NOISY CONDITIONS

Quiet Test					Noisy Test				Comparison		
1	2	3	4	5	6	7	8	9	10	11	12
Student	No. of Items Tried	20-min. Score	Accuracy	30-min. Score	No. of Items Tried	20-min. Score	Accuracy	30-min. Score	Adjusted 30-min.	P'ts in favor Noisy Test 10–5	P'ts in favor Quiet Test 5–10
A	75	74	.99	75	75	71	.95	75	71		4
B	73	71	.97	75	75	66	.88	73	69		6
C	74	69	.93	74	75	70	.93	75	71		3
D	69	69	1.00	74	75	72	.96	75	71		3
E	75	68	.91	74	75	70	.93	75	71		3
F	75	67	.89	74	75	69	.92	74	70		4
G	75	67	.89	74	75	62	.83	71	67		7
H	70	62	.89	71	72	64	.89	72	68		3
I	64	57	.89	68	69	59	.86	70	66		2
J	61	55	.90	67	53	50	.94	63	59		8
K	59	53	.90	65	68	62	.91	71	67	2	
L	55	51	.93	64	59	48	.81	61	57		7
M	57	50	.88	63	64	54	.84	66	62		1
N	57	49	.86	62	71	54	.76	66	62		
O	57	48	.84	61	59	52	.88	64	60		1
P	54	46	.85	59	73	50	.68	63	59		
Q	55	45	.82	58	62	50	.81	63	59	1	
Totals	1105				1175					3	52

Total of points in favor of quiet conditions............ 49 points
Average points per student in favor of quiet conditions.. 3 "
(49/17 = 2.9 or approximately 3)

[1] Porter, Carrie Wood. "Sound, Fear and the Power to Move," *Atlantic Monthly* 151: 637–8; 1933 (May).

It is these scores that appear in columns (5) and (9) of the data table. Column (10) is the 30-minute score on the second (noise) test after allowance for the practice factor has been made. The test manual states that the average gain when a second form of the test was given the next day after the first form was four points. Hence this number has been subtracted from the scores of column (9) to give the adjusted scores of column (10). Since, in the experiment, the two forms of the test were given on the same day, it might well be that the practice factor would actually be somewhat larger than that given above. No correction for this condition can be made, however. Any error thereby introduced would, of course, be in favor of a greater difference than was found to exist in most of the cases between the scores on the quiet test and the adjusted scores on the noisy test.

Seventeen cases is far too few to warrant the drawing of any very sweeping conclusions. Hence any statements that we make can carry little implications of general applicability. However, let us examine these data for whatever the analysis may yield.

Perhaps the most significant point about the data is the smallness of the difference—on the average three points per pupil in favor of the quiet conditions if we take advantage of the practice factor deduction. Apparently these students were able to adjust, for a short time at least, to do work demanding close intellectual application even under very noisy conditions. It may even be that the real difference is somewhat less than the three points, because of the probable injustice in deducting a practice factor of four from the scores of students who scored at, or near, 75 in the first test. Thus students who like student A, score 74 on the first test, or 75 in the transmuted 30-minute score, are obviously penalized by having a practice factor of four deducted from the score the second time, when they have already made a score on the first performance which cannot be bettered. The same condition would seem to apply to students B, C, D, E, F, and G.

It is not until we get well down toward the bottom of the group, the rank having been determined from the results of the first or "quiet" test, that we find scores in favor of the noisy conditions. Whatever may be the significance of this actually, it seems to be in line with the findings of Laird and others when, in testing typists under noisy and quiet conditions it was found that the less efficient typists were the least disturbed by the noisy conditions, some actually doing better.

The number of problems attempted in the two tests is of interest. A first examination reveals that in the aggregate the students attempted 70 more items the second time than they did the first (1175–1105). Any significance we may attach to this number may at first seem to be dissipated when we think that perhaps the reason for the practice factor of four is that the student will have time to do four more items the second time. Let's see. There are 17 students—and 17×4 gives 68—just about equal to the 70 difference. But wait. There were a number who could not improve their performance by four in this way since they tried 71 or more the first time. If we exclude these students (A, B, C, E, F, and G) we note that all of the rest, save one, J, did more items the second time than they did the first. These students (leaving out J) did 67 more items the second time, an average of a little over 6 more. This would seem to be more than would be expected because of added familiarity with the test. Whether this is a justifiable interpretation or not, it is also in line with the tests on the typists where it was found that under the effects of the noise the poorer typists often worked more rapidly.

The accuracy of the responses of the group seem to have been adversely affected

by the noise. If we take the average of the totals of columns 4 and 8 we find that the accuracy under quiet conditions was .91, under noisy .87. If we make the same divisions of the group that we have before, students A to G in one group, H to Q in the other, average accuracies of the first (A–G) group on the two tests are .95 and .91 and the average accuracies of the second (H–Q) group is .88 to .84. The equality of the shift in the two groups is not quite in line with the results of the typist test as it was generally found that the abler typists were more adversely affected as to accuracy by the noisy conditions. Again we need to be careful not to see more in our experiment than is actually there, since the skills involved in taking these tests are much more highly intellectual than the mechanical skills involved in typing.

But as we have said, the value in this experiment lies rather in its effects upon the students themselves than in the interpretation of the test scores. Hence let us learn of the effects of the test conditions as reported by the students themselves.

Student A:

Immediately upon the completion of the test, I felt a definite release of tension. Conversation seemed unnatural. Things soon became normal and I experienced no effects the rest of the day. During the night I had no dreams, which is uncommon with me. I felt fully rested this morning.

Student B:

Immediately following the test I had a slight headache and felt as though my head were trying to get away from my body. These passed away almost immediately. Several hours later I had a headache and was very irritable. I felt perfectly all right at bedtime.

Student C:

During the examination, although I was not warm, and my hands were icy cold, I was perspiring freely under the armpits. A few times when the noise was at its worst I got a slight earache which, however, left when the noise was decreased. Right after the examination I experienced a sort of numbness which lasted only a few minutes. The rest of the day I felt normal but quite tired. Once or twice I got a slight headache but it didn't last long.

Student D:

I deteced no reaction.

Student E:

The only noticeable effects on me of the experiment were (1) all sounds seemed much less loud than usual for some time afterwards, and (2) I felt much more tired than usual, earlier in the evening than the usual time that I begin to feel tired.

Student G: (F failed to hand in a report.)

The only difference that I noticed was that I was more hungry. My face was hot, and remained hot all evening. Off and on during the afternoon and evening the tips of my fingers went numb.

During the evening, my brother and I carried a trunk three long blocks. . . . After that I was . . . more tired than it seems to me I should have been. . . .

Student H:

As soon as the experiment was over and the record turned off, I found that I had a dull throbbing pain in my head and had a slightly upset feeling in my stomach. This latter feeling passed completely in a very short time, although my headache continued until I was home (about half an hour later). After that, however, all effects of the noise disappeared and I was perfectly all right.

Student I:

The effects of the noise test on me were a general pressure on my ears,

my hands were cold, my face hot and a completely deadened feeling for about one-half hour after the test. In the evening the only effect was a tiredness of my eyes.

Student J:

I felt stimulated right after the test, but later the effect was one of fatigue.

My nerves were at an edge. I went to bed feeling abnormally tired. I slept "like a log", waking up in the morning fairly refreshed.

Student K:

No effects . . . except, perhaps for a slight feeling of exhilaration. . . .

Student L:

. . . I felt as if a round soft brush was revolving in the middle of my ears. My whole head felt rather heavy although I didn't have a headache. I ate supper with normal appetite but was a little more tired than usual in the evening.

Student N: (M failed to hand in a report.)

Noticed no change after noise. Had slight headache during test but not after it. Only thing I noticed was a slight effect on my ears for a few minutes afterward.

Student Q: (O and P omitted.)

My only reaction was a slight headache for about an hour after the test ended.

The writer's own experience most closely parallels that of student H. The nausea to which H refers was so bad in my own case as to make it difficult to carry out my part of the experiment i.e. timing and manipulating the controls for volume and pitch. The nausea passed but a headache persisted during the rest of the day. The rather abnormal fatigue which several mentioned was present in my case also.

Now, of course, we should beware of attaching too much importance to these statements. The students knew before the experiment that noise is supposed to have rather pronounced effects. It may be therefore that some, or perhaps most, of the effects reported can be explained in terms of the psychology of suggestion. That all effects may be so dismissed would seem doubtful. In any event, one of the main purposes of the experiment had been realized in that the students participating had gained a very real appreciation of what it means to work under conditions of extreme noise and had personally experienced the results of such noise.

One rather interesting offshoot of the experiment is that it seemed to be newsworthy. Word of the experiment having reached a member of the public relations staff at Teachers College, it was passed on to several reporters, one of whom sought a personal interview. The story "made" the New York World Telegram of October 14, 1938, under the erroneous title "Loud Noise Sharpens Wits of Only One Pupil in Test" (Actually there were two—students K and Q) and the Teachers College edition of the Columbia Spectator, under the title "Roars, Rumblings, Shrieking Sirens Mark Lincoln Noise Experiment."

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BIOLOGY AS CULTURAL BACKGROUND

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Education for culture is receiving increased recognition. This is probably due to a renewed or better understanding of what culture is. It also may be due to a better selection of material incorporated into cultural courses. If culture may be accepted as that training and understanding which will be of the greatest assistance in the interpretation and satisfactory realization of experiences, there should be no hesitation in striving for it. Such a conception is quite in line with the accepted statements which are embodied in the general objectives of education in secondary schools and the non-professional courses in college.

If the above definition is acceptable, then cultural education is desirable finishing education or a preparation for professional training. It is not contended, however, that classification as cultural and professional is any more than arbitrary, for professional education may well be cultural, and cultural education a very important and practical final preparation for a profession.

Personality has received a renewed interest in current thought. Personality is, however, of no greater importance than the contributions its possessor contributes to the mutually happy and profitable interrelationships between individuals. The teaching of many of the early philosophers, the basic themes of religions, and the recorded utterances of statesmen, business men and others of attainment whose biographies have been a part of our cultural background, contain numerous rules of conduct. Such rules have been distinctly empirical. Certain philosophies assume that the individual is endowed with altruism, but for one reason or another, he may become possessed of the devil. As the devil invades, altruism wanes. Teachings, accordingly, consist of warnings against this undesirable tendency and exhortations to free one's self of the evil invasions.

Biology has no such particular merit as has a training in reading, writing, or other of the fundamental working tools for learning, but it is filled with fundamental facts that are useful culturally and professionally.

Behavior stands apart from other phases of biological study because for the most part it is composed of the various acts of the individual that are acquired by experience as development proceeds. Nevertheless, behavior is determined in a large measure by the potentialities and limitations of the individual's inherited physiological and structural endowments.

One does not proceed far in the study of biology before he is struck with the fact that variation among the characteristics of organisms is very common. Such variation is most readily observable in structure, but technical studies have revealed that it is as fully an important factor in the biochemical composition and thus in the functioning of the individual. Another important fact is that experience begins at birth, or before, as the individual begins the performance of fundamental processes of existence. Thus there is from the outset a highly variable structure with variable adaptations which is subjected to a continually varying set of experiences. Therefore, any one individual is a complex of these variable characters inherited and modified by experience which are distinctly different from those of any other individual.

What even approximately general facts of biology, in this complexity of interdependent factors, are of assistance in un-

derstanding human traits that compose personality and, in a broader sense, social adjustment? Seemingly they are those most basic to life, and consequently, are those dealing with what are commonly included in the general facts or principles of biology. At least four may be cited.

One of the fundamental requirements of organisms is nutrition. Among higher forms this involves eating and various controlled (intelligent) activities in obtaining food. Under competitive conditions there arise skills and physical attainments among competitors in securing food, particularly as the supply diminishes. Among carnivorous animals and their prey there occur in the predators, adaptations to pursue and catch prey and among the organisms preyed upon, defense organs and adaptations for escape, such as senses that give warning and abilities in suitable flight.

Another common characteristic among organisms is the fact that they practice periods of rest, repose, or even dormancy. Among higher organisms, at any rate, such rest is necessary to recover from fatigue. Cessation from motor activity fosters many normal physiological processes. In man, certainly, and possibly in other organisms, such periods result in new neuro-sensory patterns (thought). To secure such repose, certain conditions must prevail, and to secure them it is evident that many higher animals, including men, put forth a vast amount of effort.

Some of the conditions fostering repose are proper temperature, freedom from mechanical strain or compression, relaxation of motor muscles, and an absence of external stimulants to the specialized senses of hearing, scent, sight, touch, and taste. Fully as important, there must be lack of stimulation of those more general but more complex systemic senses such as fatigue, excitement, and toxic physiological disturbances. It is also a common observation that animals and man resist, even to the point of combat, any agencies that disturb their respose or pursuit of peaceful requirements.

A third essential in the life of organisms is reproduction. Among the simplest forms, such as plants, bacteria, and protozoa, the process appears to be no more than a passive function conditioned by external factors, factors that in many cases may be easily controlled by experimental manipulation. Among higher organisms wherein only sexual reproduction occurs, the process becomes more complex. One of the complexities is due to the sex sense. Therefore, in addition to the structural and better understood physiological relationships of this function which may involve the entire organism, there are also the neuro-sensory relationships. Thus, because experience, habits, training and specialized senses have contributed to the conditioning of the nervous system and its complex retentive ability, the sex sense may involve to a very high degree other functions that are controlled by the nervous system. Furthermore, in response to the nature of the reproductive function, it is observed that organisms exert extreme effort to comply with its demands. In one celled organisms, the individuality of the cell is obliterated in the regeneration of two new cells. Among perennial plants, during the formation of seed, vast reserves are drawn upon, in extreme cases, even to exhaustion. It is a well known fact that among certain fish, effort to reach spawning environment is put forth with determination and even at great sacrifice. The preparation of the nest and care of the young by birds is familiar to everyone. Competition in mating to the limits of death struggles is recorded for vertebrates.

For the purposes of this discussion, a brief reference to a fourth characteristic of organisms is desirable, namely, inheritance. Inheritance determines in the offspring structural characters, physiological behavior as well as the potentialities and their limitations in acquiring habits, skills, *et cetera*. Predispositions to certain disease within a strain likewise may be inherited by the next generation. Certain inheritable traits may occur in combina-

tions, advantageous or otherwise, that are not found in either parent. For example, a combination of an especially acute sense of smell from one parent and excessive speed from the other, results in a trait in excess of that possessed by either parent, enabling the off-spring to better avoid danger.

The preceding is an approximate statement of a part of our knowledge of living organisms. Many examples might be cited and the facts enlarged upon, but this has been done abundantly elsewhere. Except for the highly specialized forms, the facts in the main are common to all organisms, including human beings. Among humans, it may be granted that there are additional endowments, but it still must be admitted that such additional endowments are additional and not replacements. Certain additions, such as a high degree of intelligence, for example, might be expected to have some controlling influence over undesirable tendencies, although the question has been raised whether such additions have not tended to be more destructive than constructive. Entertainment of such a view is, however, undesirable.

What has all of this to do with our understanding of human behavior? Probably more than is generally recognized in an appraisal of the individual. Behavior of individuals determines the behavior of society. Social adjustment in its broadest application involves not only state and other community welfare agencies, but the individual in his everyday dealings. Improvement must appear in the individual before we can expect improvement in society. Recognition of these facts is found in literature on social welfare.

Among agencies primarily interested in the improvement of the individual's behavior and usually included under the term "Personality", we find schools of salesmanship and personnel departments provided by employers for their employees. Other recognition of the value of the human factor is observed in the emphasis placed by an employer upon the personality factor in seeking employees. Training in the development of personality or its appraisal in candidates is little concerned with the fundamental understanding of what may contribute to behavior. Physicians and sociologists have long recognized the influence of physiological derangement and human environment. But their attention has been devoted to extreme cases and has been little concerned with the individual who has kept out of jail or other corrective institutions.

Such traits of human nature as the common courtesies, cooperativeness, coordination of activities, recognition of the other fellow's intelligence, pride and feelings; willingness to accept or at least listen to the other fellow's point of view as opposed to overbearingness, ballyhoo, selfishness, greed, strutting, argumentiveness, bluff, and a much longer list of other desirable and undesirable characteristics are those that have to do with social adjustment. Undesirable traits seem to be closely related to misdemeanors, unfair trade practices, crime, quarrels, warfare, bad leadership in politics, racketeering, and a host of other social maladjustments.

Tracing back to experiences that are provocative, one is inclined to believe that originally such traits grow out of rather basic biological origins as cited above. Certain psychological traits are often cited as basic considerations in behavior. From among these let us consider only one—vanity. Although vanity does not appear as such in biological teaching, the possible sources of it may be derived from the mating habit as a concomitant of reproduction or from a quest for leadership in gregarious undertakings of defense, nutrition, or shelter as found among organisms; it is certainly evidenced clearly in the history of man. Leadership is undoubtedly found among social insects, but its responsibilities are so divided as to render their organization a more nearly "perfect" social order. Among these insects there is no evidence that such a trait as vanity has developed as a result of competing for

leadership or pride in performing duties. If such is the case, vanity may be considered as a secondary derivative of biological experience and not necessarily, basically inherent to socialized life, but that when it does appear it may become a cause of social maladjustment.

Logically, the question may be asked: Do the fact of biology make more understandable the behavior of man and how can such understanding aid in seeking remedial measures to correct social maladjustments. Corrective measures in vogue seem to be preaching, laws, the building of institutions for the misfits, more rigid enforcement of the laws, and the negotiation of more peace pacts. The effectiveness of this system seemingly is falling behind the increase in maladjustments. Another answer is to educate people better, not only in behaviorism as applied to social adjustment, but also in the biological fundamentals and their full value as the direct or indirect cause of behavioristic traits.

As has been stressed elsewhere, educational concepts are not completed until applied. General rules of conduct without reference to reasons for their enactment can accomplish much in the early youth, but as the individual matures, his individualism and perfectly normal development of independence express themselves by questioning the set order of things and unless such an individual understands that other individuals likewise have primary urges of nutrition, comfort, and reproduction he is not likely to understand until too late that touching wires of high potential may result in shock or if an uninsulated contact is made, in death. Complete social adjustment is more than the practice of the rules laid down by authorities on personality or by compliance with laws. It requires a more complete refinement. Proper refinement will result from a clear scientific understanding of all that is involved. With such understanding, society can intelligently seek effective remedies for the cause and not superficial ones that soon lose their force. Responsibility for such attainments must rest with formal education because there must be widespread and comprehensive intelligence.

One principle sometimes cited as prevalent among lower animals has not been referred to because it is not found in authoritative literature of biology, namely, "Dog eat dog." Whether it will become an accepted principle applicable to man rests with him. That is, can he and is he willing to exercise and apply sufficient intelligence to guide his intelligence into all channels ultimately profitable to himself?

Advances in knowledge and applied training have given to man tools and weapons to accomplish much for his own betterment. Today, the greatest use to which man is applying these attainments is individual and immediate advantage without regard for the social damage that is being wrought. This is largely a matter of ignorance; ignorance of the inevitable behavior of an organism (man in this case) in pursuing activities to avail himself of the more basic biological requirements. That is, man does and will continue to employ the processes, machines and weapons he has devised to satisfy his basic biological requirements, but in their use he unwittingly sets traps for himself and his neighbors. In contriving methods of avoiding social dangers, however, due consideration of the natural reactions of the individual must be recognized so that desired regulation does not conflict with human behavior but is acceptable to it.

Among the necessary steps in such regulation widespread and truthful education must come first, education of the leaders as well as those to be led. Refinements due to scientific progress may appear to be dangerous. Science, however, has kept pace with safeguards on the physical side, but not with the social problems which have arisen. The social problems are inherently biological; and improvement must be sought which gives due regard to basic biological laws.

SCIENTIFIC ATTITUDES[1]

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In most of the contemporary formulations of the objectives of instruction in secondary school science the attainment of both the scientific method of thinking and the scientific attitudes has been stressed. But, despite the coördinate importance assigned to the two, the scientific attitudes have been less well defined than the steps in the scientific method. Nevertheless, because the importance of the scientific attitudes has been generally recognized, a number of studies have been based on the existing incomplete formulations of them. Such studies have included attempts to develop, and to evaluate, methods and materials for teaching the scientific attitudes, to develop tests of the possession of them, and to determine any effects on the behavior of persons learning them. Such studies are undoubtedly desirable, but they seem to have been premature. They might have been more valuable had they been based on a more nearly complete definition of the scientific attitudes.

THE PROBLEM

The primary purpose of the study was to discover, and to state in definite and unambiguous propositions, as many as possible of the working assumptions and rules of practice which have been termed scientific attitudes. A secondary purpose was to discover the extent to which these scientific attitudes had been recognized in the professional literature of general science teaching.

A new definition of a scientific attitude is implicit in the above statement of the problem. It seems quite inconsistent with many of the propositions derived in the study to carry over into science the psychological definition of an attitude as a "feeling tone", or as a "stabilized set or disposition", or as a "habit of thinking". Neither are scientific attitudes to be regarded as scientifically desirable forms of "emotionalized attitudes".

A scientific attitude may be either of two different things. It may be an assumption made as a basis for work, such as the assumption that anyone is liable to make mistakes (Cf. Attitude 75, below). This proposition is compatible with past experience, but for the future it is only probable, an assumption. Or, a scientific attitude may be a rule of practice, such as the rule that every effort must be made to prevent, and to discover and correct, possible mistakes (Cf. Attitude 76, below).

Scientific attitudes are assumptions and rules of practice which have been formulated consciously and deliberately, or at least have been subjected to searching criticism since their formulation. They are neither sacrosanct nor necessary. They are convenient and fruitful only. And blind habituation to them, or any emotion attached to them, is undesirable, for it might prevent the discarding of any which conceivably might prove no longer useful. Scientific attitudes are simply elements in the philosophy of science.

METHOD

The first part of the study consisted of a critical analysis of twelve published works of the philosophers of the last half-century. The scientific attitudes so found were studied, and reported, by classifying them as to their applications to the three

[1] Abstract of a dissertation submitted to The Graduate Faculty of the Teachers College of the University of Cincinnati in partial fulfillment of the requirements for the degree of Master of Education, June, 1938.

steps of the scientific method, given by the writer as (1) experiencing sensation, (2) classification of sense data, and (3) the elimination of any classifications whose implications are incompatible with the sense data.

In the second part of the investigation seventeen related studies were analyzed to determine which of the scientific attitudes derived above they had recognized.

The philosophical works selected for study were:

H. Poincare	*The Foundations of Science*
E. Mach	*The Science of Mechanics*
B. Bavink	*The Natural Sciences*
G. Santayana	*Reason in Science*
J. Dewey	*The Quest for Certainty*
Good, Barr, and Scates	*The Methodology of Educational Research*
Cohen and Nagel	*An Introduction to Logic and Scientific Method*
K. Pearson	*The Grammar of Science*
J. Huxley	*What Dare I Think*
B. Russell	*The Scientific Outlook*
F. Westaway	*Endless Quest*
A. Wolf	*The Essentials of the Scientific Method*

The authors of the related studies in the field of general science teaching were: Twiss, Meister, Eikenberry, Curtis ('24), Craig, Downing, Curtis ('29), Rice, Davis, Hunter and Knapp, Beauchamp, Skewes, Noll, Watkins, Bickel, Caldwell and Curtis, and Crowell.

FINDINGS

The outcome of the first part of the study was the definition of ninety-two scientific attitudes. They are presented here in eighteen groups subordinated to the three steps of the scientific method already developed:

Applicability of the Scientific Method

1. The scientific method is applicable to any materials that can be reasoned on.

2. The scientific method must not be barred from any materials that can be reasoned on.

3. The scientist is not interested in any materials that can not be reasoned on.

The first step in the scientific method is the experiencing of sense-impressions.

Sensitivity of Perception

4. The scientist must be responsive to sense stimuli.

5. The scientist must keep his sensitivity to stimuli as high as possible.

Accuracy of Perception

6. The scientist must be accurate; *i.e.*, his response must in some consistent way be proportional to the stimulus.

7. The scientist must guard against anything that might make his response to sense stimuli inaccurate.

8. The possibility of agreement between different observers depends upon the similarity of their perceptive faculties.

Objectivity of Perception

9. All measurement is relative to an accepted standard.

10. The scientist must compare anything being measured as directly as possible with the standard, not indirectly through his memory of it.

11. The use of instruments permits a great increase in both the sensitivity and accuracy of observation.

Limitation of Perception

12. It is highly probable that there are phenomena no observer has sensed yet.

13. No one is able to make even an outline of all possible future developments in science.

The second step in the scientific method is the classification of sense-impressions on some basis, that is, the formulation of scientific laws and hypotheses. With sense-impressions, as well as with data of greater complexity, this process is called generalization.

Materials of Science

14. Without sense-impressions there would be nothing to be known.

15. The materials of science are not immediate sense-impressions, but rather inferences based on such sense-impressions.

Scientific Classification

16. The scientist is interested in a particular event only in so far as it is an example of a class of phenomena.

17. Scientific classification, by grouping phenomena, facilitates the comprehension of them.

18. Scientific classification makes possible the concise recording of experience.

19. Scientific classification makes easier the education of the uninformed.

20. Statistics is very helpful in comprehending numerical data.

Sampling

21. Whatever is true of a fair sample will be found to be true of the class from which the sample is taken.
22. Only if a sample is truly representative of a class can the nature of the class be inferred from that of the sample.
23. No characteristics found hitherto associated only with a nervous system may be inferred where no such nervous system has been found.
24. No one can reason across a breach in the routine of experience.

Nature of Scientific Law

25. From his experience a scientist may predict that if certain complexes of conditions exist, then certain other complexes of conditions will, or do, exist.
26. Only if past experience is a fair sample of future experience will scientific laws based on past experience be valid in the future.
27. A scientific law expresses a relation between only certain elements abstracted from experience.
28. No scientist can say just what the implication is between a "cause" and its "effect."
29. A scientific law does not imply any compulsion exerted by a "cause" to produce an "effect."
30. A scientific law does not imply any teleological connection between a "cause" and its "effect."
31. A scientific law does not refer to a concatenation of natural phenomena considered as outside, and independent of, the scientist.
32. Scientific law is not a transcription of some prodigious code prescribed by some higher power.
33. A scientific law does not "rule nature."
34. A scientific law exists only when it is formulated by the scientist.

Nature of Hypotheses

35. A hypothesis is the assumption of something beyond sense-impression for the sake of correlating sense-impressions.
36. The formation of any hypothesis is logically invalid.
37. Sensations are not signs of things; but on the contrary, a thing is a thought symbol for a compound sense-impression of relative fixedness.
38. Any given sense-impression can be explained by more than one hypothesis.
39. There is no sharp distinction between fact and hypothesis.
40. It is unnecessary, as well as unjustified, to hope that a hypothesis should represent any thing beyond sense-impression.
41. The mutual incompatibility of some hypothetical conceptions in science results from their not being sufficiently abstract.
42. It must never be forgotten that hypotheses correlate only abstract elements of experience.

Formation of Laws and Hypotheses

43. There are no known rules that can be followed mechanically to arrive at useful hypotheses.
44. Not all possible hypotheses can be enumerated.
45. Thorough knowledge of a field of subject matter is conducive to the formation of useful hypotheses in that field.
46. Inspiration, or intuition, is essential to the formation of hypotheses.
47. Valuable laws and hypotheses spring more often from a spirit of curiosity, or of inquiry for its own sake, than from hope of financial gain, or of increased prestige.
48. Ultimately the direct influence of pure science on practical life is enormous.
49. Critical dissatisfaction with things-as-they-are is more productive scientifically than admiration.

The third step in the scientific method is checking the stated relation in the scientific law, or the implied relations in the hypothesis, against sense-impressions to make sure that such relations exist. Stated differently, the third step is the elimination of incompatible laws and hypotheses.

No Possible Proof

50. It is a fallacy to "affirm the consequent."
51. The "argument from design" is not valid.
52. No law, or hypothesis, can be proved; it can only be shown to be compatible with sense-impressions.
53. Of the hypotheses compatible with the facts, the best hypothesis is that which is the simplest systematically.

Compatibility with Accepted Concepts

54. The statement of a law, or hypothesis, must be clear and unambiguous.
55. All assumptions made must be clearly stated as such.
56. A hypothetical proposition must be differentiating; it must not explain no-matter-what may happen.
57. A hypothesis must account explicitly for all relevant concepts which are accepted at the time of its formulation, either by corroborating or by discrediting them.
58. Results taken from other workers must be criticized as searchingly as are one's own.
59. Whenever a law, or a hypothesis and its logical implications, is not compatible with sense-impressions it must be revised until it is compatible.
60. When his hypotheses and laws are shown to be inadequate the scientist revises them to form closer and closer approximations, rather than discards them to start completely anew.
61. A hypothesis need not be true to produce valuable results.

Test by Experiment

62. The one most important check on itself the scientific method has is the over-all check against sense-impressions.

63. If data of record relevant to a proposed law, or hypothesis, are insufficient for judging it, additional data must be gathered by an experiment designed to test it.

64. If two complexes of conditions, C and E, do not vary concomitantly, then C and E are not causally related.

65. It is a fallacy to assert that if two complexes of conditions, C and E, do vary concomitantly, then C and E are causally related.

66. In order to establish a concomitant variation between C and E the ability to measure both C and E is necessary, and statistical methods of handling the data are desirable.

67. If E ever occurs without C, then C and E are not causally related.

68. If C ever occurs without E, then C and E are not causally related.

69. In an experiment all relevant, independent variables but one should be held constant.

70. It is impossible for the scientist to hold constant all independent variables but one.

71. The relevance of any variable can be determined only by experiment.

72. The effect of two "causes" acting simultaneously is calculable from the effects they have separately.

73. Successful prediction of phenomena, in fields different from that in which it was derived, is strong evidence for a hypothesis.

74. It is a fallacy to argue that a proposition is true simply because it has not been, or cannot be, proved false.

Guarding Against Error

75. Any, and every, one is liable to make mistakes.

76. The wise scientist will use every conceivable means to prevent, and to discover and correct, possible errors in his work.

77. The effects of unavoidable errors of observation may be minimized by applying to them the theories of probability.

78. Failure to correct errors often gives rise to superstitious beliefs.

79. The scientist attempts to form judgments which will be independent of the idiosyncrasies of his individual mind.

Renunciation of Emotion

80. The scientist deliberately renounces all emotion and desire, except that of accomplishing his twofold purpose.

81. The scientist should never make pontificial announcements, nor indulge in melodrama.

82. If the scientist is ignorant on certain points, he must acknowledge his ignorance on those points.

83. The scientist's acknowledgment of his present ignorance is not a resignation to defeat; it is rather that which leaves open the way for future investigation.

Persistent Search for Adequate Conceptions

84. A hypothesis must not be accepted so long as other hypotheses have probabilities of the same order.

85. The search for adequate laws and hypotheses must persist not only in one man but in generations of men.

86. There is no abstract principle by which the nature of things can be predicted before the investigation of them.

87. No concept, no matter how it was arrived at, should be adopted until it has been shown to be compatible with sense-impressions.

Mind Open to Necessary Change

88. There is no idea so firmly established that it may not at some time need to be changed.

89. Mere intensity of belief in a proposition is no guarantee of its truth.

90. Neither custom nor tradition can guarantee the validity of any conception.

91. No authority can guarantee the validity of any conception.

92. No scientist can slough the responsibility for making his own decisions.

The second part of the study revealed that there had been fairly general recognition and acceptance of the scientific attitudes grouped under the following topics:

(1) Applicability of the scientific method
(2) Limitation of perception
(3) Materials of science are drawn from sensitive, accurate, and objective perception
(4) Hypotheses and laws must be compatible with accepted concepts
(5) Test by experiment
(6) Guarding against error
(7) Persistent search for adequate conceptions.

Also, it was shown that the attitudes under the following heads had been neglected almost completely, namely:

(1) Laws and hypotheses are based on samplings of experience
(2) No conception can be demonstrated to be necessarily true.

Similarly, there were other attitudes which had been recognized after a fashion, but evidently had been understood in senses quite different from those developed in this study. Such attitudes were included in the groups under the following categories:

(1) Nature of scientific law
(2) Nature of hypotheses
(3) Formulation of laws and hypotheses
(4) Necessity of renouncing emotion in scientific work.

This analysis of the related studies showed that no one of the earlier workers had defined more than twenty-seven of the scientific attitudes which were developed in the first part of the present study.

APPLICATIONS

Such attempts as have been made to develop, and to evaluate, methods and materials for teaching the scientific attitudes, to develop tests for the possession of them, and to determine any effects on the behavior of persons learning them, while undoubtedly desirable, seem to have been premature. If they had been founded on such a more nearly complete definition of the scientific attitudes as this they might have been more valuable.

If the analysis of the scientific attitudes derived herein is valid, and if the individual scientific attitudes are suitable as goals of instruction in general science, then general science teachers must make a part of their philosophy such of them as they have failed to recognize, and must become better acquainted with those they have grossly misunderstood. If the authors of textbooks—if the teachers themselves—have no clear conception of these scientific attitudes, just how do they expect to teach them to science pupils? Offner has listed [2] a number of offenses against the scientific attitudes, and has quoted several examples from textbooks which have erred in presenting theories as established facts. Others,[3] too, have stressed that teachers must educate themselves before they can educate their pupils on this point. To the extent of learning these elements of it, then, professional science teachers should acquire a philosophy of science.

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MAKING USE OF MOTION PICTURES IN TEACHING SCIENCE *

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The glittering appeal of powerful motion pictures and the glamour of the gigantic business as a whole has cast a spell over the world. Education through entertainment, without anyone's design, has become a distinctive factor in the life and philosophy of this generation. It would be quite regrettable if we were to reach the point where education through entertainment became the only approach to instruction. Fortunately, however, level-headed educators have managed to promote a few outgrowths in the form of curricular motion pictures. In a true teaching film the entertainment appeal has been changed to an intrinsic interest appeal. The informational content has been elevated from pure propaganda for a manufactured commodity to the portrayal of important illustrations germane to a particular lesson objective.

The popular tendency to lean on the film, to expect it to carry both teacher and class along with it, without the expenditure of a due proportion of mental energy must be definitely combated.

The methods a teacher employs in integrating the use of a film with other instructional activities of the classroom largely determines how much the students are going to get out of the film experience.

Teaching with films is NOT a matter of showing a picture to passive observers and hoping it has done its work. Proper teaching with films is dynamic, exploratory, interpretive. Certain it is also that the motion pictures available for school use are of exceeding unequal value. It is almost proverbial that the typical free industrial film may be educationally the most costly. The free commercial films are too frequently subtle proselytism through entertainment under the guise of education. Their abundant footage cannot be intergrated with lesson—aims at least for sake of any real economy.

Consequently the preparation which the skillful teacher makes for using the film involves some careful planning. I have hazarded a contrasting characterization of observable teacher-types using films in our Rochester schools. Believing that we can all see the mistakes of the other fellow when they are presented as a pattern in relief, I present this epitome of techniques.

Proper classroom use of films for the teacher is fully as enervating as teaching without films.

Presented below is a contrast of two types of teachers, each contemplating the use of a film, and the thought-processes of each that occur.

Type A begins rationalization before the instruction in the unit of study begins, thus:

1. What are the objectives of the unit I am to teach?
2. Are there any true teaching films available for use with these objectives?
3. At what point in my instruction, where screen illustration is desirable are MOTION pictures really necessary?
4. What particular film will be most helpful?
5. How well do I know this particular film myself?
6. What will the accompanying teacher manual reveal to refresh my memory of the film?
7. What supplementary printed or demonstrable material will help with this film lesson?
8. At what point in the unit should I introduce the film?
9. What do I expect the film to accomplish at that point?

* Discussion before the annual meeting of the N.Y.S.S.T.A. in Syracuse, New York, December 29, 1937.

10. What activities or projects might be started as an outgrowth of the first or subsequent showing?

(This is the skillful film-teacher)

Type B soliloquizes at 8:30 A. M. of any morning which a particular unit of study is under instruction, thus:

1. Where in my instruction, can I work in this entertaining film?
2. Can I get this free commercial film for today's use?
3. Even if there is a set of slides on this topic, won't the pupils enjoy a film more?
4. What films are now in the building that I could borrow from another teacher?
5. That title sounds good. Could I show it to my class this period and thus see what it is like?
6. Haven't I seen this film before; what was it about?
7. When I use this film I can assign a pupil to write an essay upon it and fill the period, can't I?
8. Can't I use it today while it is here?
9. Won't it be easier for me to let the film teach this lesson?
10. Won't the pupils be motivated toward the study of this topic better, if I can show any film related to it?

(This is the laissez-faire film-teacher)

Freeman, McClusky, Weber, and others, by experimental studies, point to the proof that the motion picture method can be profitably set aside for non-motion pictures, models, specimens, and allied visual aids when the subject does not require action or progressive demonstration for its illustration.

Correct the mistaken notion that all students see—and with sound films even hear—the same things in a picture. A pupil is conditioned by his background of experiences from which certain interests and understandings have grown. Naturally he attends to elements of the film presentation which attracts his attention as both comprehensible and appealing. It is the teacher's task to make sure he has a background for pereciving those visual and sound images of the film which are important in attaining the purposes of the lesson," says Brunstetter.[1] Failure at this amounts to presenting a film "cold" and then hoping that it has done its work.

"The teacher's procedure in introducing the use of the film in the lesson is of more significance than is commonly realized. In the first place, it gives the student a perspective for looking at the picture. The questions the teacher asks and the comments he makes throw into bold relief certain elements of the screen presentation, thus controlling to a large extent what the pupils are going to get from the picture. The technique for introducing the use of the film therefore overlaps that of adapting the film to the current interests of the class, since both involve setting the stage for the use of the picture."[2]

"The motion picture derives its educational effectiveness not from what it is, but from what it can do. What it does may be either largely informatory, largely stimulative, or largely clarifying."[2]

Each showing of a film must be made purposeful in terms of pupil interests and needs. The most frequent value of the motion picture, measured experimentally, lies in answering questions already in the mind of the child.[3]

There is a real difficulty encountered by the earnest teacher who attempts to find current articles reporting any exact use made of visual materials. Unfortunately too many articles submitted to an educational journal, by a teacher who develops a successful unit of instruction and reports it, are brief and sketchy. They offer but few concrete and helpful suggestions for a beginner.

To make more concrete, and to us, more mentally visual this recital of general principles, let me describe actual teaching situations where we would use films for different purposes in the classroom. By the word films used in this connection I include both sound and silent pictures for which these techniques are identical.

[1] Brunstetter, M. R., *Interesting Uses of the Educational Sound Film,* New York, Erpi Picture Consultants, Inc., 1936.

[2] Rulon, Phillip J., *Sound Motion Picture in Science Teaching,* Harvard University Press, 1933.

The use of films to initiate a unit of instruction to stimulate interest and so lead into a unit. Example: In General Science State Syllabus, 9th Grade.

At end of unit on Use of Fuel in the body is the study of effect alcohol on cellular life. An experiment with protozoans in a microprojector is suggested. This demonstration requires pupil initiation in order to build a concept of uni-cellular life. The Eastman Teaching film, *Microscopic Animal Life*, presents photomicrographic views of amoeba, paramecium, stentor, and others. To introduce this work pupils may be referred to their previous acquaintance with the cell as a unit of living things. Then introduce the problem: What is the effect of alcohol upon protoplasm of living cells? Present the idea that we can most easily study this effect by experimenting with one-celled animals but to understand what normal behavior contrasted to alcoholic effects are, we must observe these cells, normally first. Almost immediately the question arises from the pupils: "Where do we find protozoans? How can we see them? and what do they do and eat?" These inevitable pupil questions are then referred to the film showing where they are answered. With oral discussion subsequently, pupils are directed to a conception of normal protozoan behavior and adaptations.

Now the class is ready to interpret and understand the behavior of paramecium culture in the microscope or micro-projector both normal and alcoholic.

A second example comes from unit I in General Biology whose objective is to bring pupil recognition of the diversity of living forms. Develop a problem with the pupils: "What are the different kinds of living things found in different parts of the world?" For purposes of rapid survey, the proposed method of instruction in this course, we find valuable such films as *Arid Southwest, Alaska, Some Seashore Animals*, and *Some Larger Mammals* not all presented during the same period. Each film showing is highlighted with respect to the objective of this unit. Such highlighting may be done by oral discussion during and after showing or by socialized outlining or charting on blackboard or in notebooks.

After showing three or four (never more than two films a period) the pupils have a common background upon which to base the development of the concept, *i.e.*, man is one of many species of living things. Through subsequent activities and lesson projects we develop the details to establish this objective.

The use of films as a direct teaching aid to establish concepts of a unit. Example: When in Physics or in Chemistry the following problem is reached: "How may water be changed to a gas without boiling it?" or "How may hydrogen and oxygen be obtained from water by electrolysis?" The usual apparatus is connected to the electric current. The student sees the formation of the gases in the two tubes. The volumes are noted and the standard tests for oxygen and hydrogen are applied. The discussion leads to the question: "What goes on inside the solution to cause this gas formation?" Here the General Electric film, Beyond the Microscope, can be used to decided advantage. The central scenes of the film show by a series of moving diagrams the attraction of hydrogen ions to the cathode. There they give up their charges and become hydrogen gas. The negative SO_4 radicals pass to the anode where they are united with water molecules to form more acid and oxygen is liberated. Only that part of the reel which pertains to this action is used. The class now turns to answer questions in the manual. If such questions are asked by the pupils which indicate it had passed too rapidly, the picture can be shown again. This gives the student a moving picture of what goes on inside the solution. Anderson [3] reports quite improved under-

[3] Anderson, O. S. "Complete Learning Through Visual Aids in Physics." *The Educational Screen* October, 1937.

standing of the process of electrolysis by classes under this technique not using the picture. This is my own repeated experience during the past six year.

An example from General Science: In the study of digestion absorption and distribution of foods with emphasis on structural adaptations, the lesson problem: "How is the body adapted to digest food?" is arrived at. Pupils are assigned a workbook sheet, headed by this problem and laid out in tabular form for answers like this slide. (Figure 1.) From books, hu-

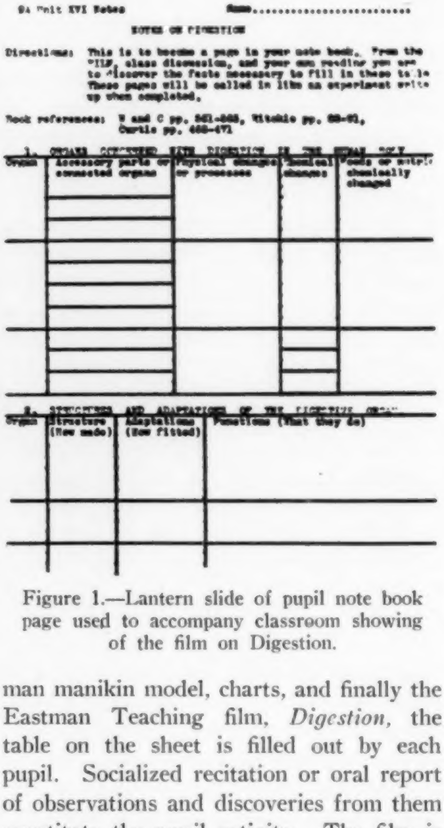

Figure 1.—Lantern slide of pupil note book page used to accompany classroom showing of the film on Digestion.

man manikin model, charts, and finally the Eastman Teaching film, *Digestion,* the table on the sheet is filled out by each pupil. Socialized recitation or oral report of observations and discoveries from them constitute the pupil activity. The film is shown first through once so that pupils may observe the complete exposition with a well-defined development of thought. The subsequent showings of the film consist of one scene at a time, interrupted by discussing and recording on the exercise sheet, the details of organic structure and adaptation observed in the film.

The use of films to enrich or extend a unit. Example: The use of the film, *Water Cycle,* in the eighth grade General Science class studying the unit on weather factor measurement.

This film, by its own title, would normally have been an integral part of instruction for the seventh grade unit on the Water Cycle but is introduced under the study of weather again to illustrate the progressive changes in cloud forms whereby storms are observed. This is an extension of the mere reading of thermometer, barometer, and wind-vane to aid weather prediction by showing, graphically what is happening in the sky while instruments are changing.

Or the use of the Erpi sound film to correlate with the study of sound in Physics, titled, *Sound Waves and Their Sources,* is an enrichment. Sound waves are depicted by means of progressive diagrams and the oscillograph. Here an auditory image is simultaneous with the visual image and vivid analysis of tone qualities is presented. The unit of study is thus extended by use of the sound film beyond the possibilities of demonstration with high school equipment.

The use of films for purposes of rapid survey or building background. Example: In either Biology or General Science where the units of study deal with cellular structure the Eastman Teaching film *The Living Cell* presents a variety of microscopic views showing cell modifications.

With prepared teacher comment accompanying, or class discussion following the film, a common pupil concept of the unity of cellular life can be engendered. This provides background from which further laboratory activities dealing with specialized cell functions can be integrated.

In ninth grade General Science a silent film, *The Green Plant* is used to present a survey of plant processes in relation to

food supply for other life. We show this film to our classes and then provide pupil activity in the form of a notebook page diagram wherein pupils are led to localize their labels of processes and functions with plant parts as they were localized in the film's presentation. The rapid succession of Key experiments on Photosynthesis, Respiration, Osmosis etc. that follow in the syllabus are thus related to a background or overview of plant life in general. The pupil has constructed his own pattern of the unit and sees the individual experiments in relation to the whole. Of course a repeated showing of this film to summarize the experiments at the end of the unit permits the pupil to check the accuracy of his Key diagram in light of both the experimental results and film concepts.

The use of films to summarize or review. Example: After completion of the unit on heat-transfer in General Science, we find the Eastman Teaching film, HOT AIR HEATING serves better as a review and extension device than in any other capacity. A pupil activity such as answering flash questions on lantern slides similar to these (Figure 2) compels pupil reaction. Even

1. Is it suction or pressure that produces the rise of water in a lift pump? From what the film showed, give reasons to support your answers.
2. Explain why or why not, breathing is possible without atmospheric pressure.
3. Why does not the pressure of the atmosphere crush live bodies?

Figure 2.—Typewritten lantern slide of questions for pupil activity in a review lesson using the film ATMOSPHERIC PRESSURE.

a written report of many applications of our knowledge of heat transfer is a worthy assignment since the film has helped the pupil review and summarize the facts studied in this unit.

For Physics classes we are inclined to regard the film *Atmospheric Pressure* as a better review film than an exploratory one because we have usually been able, with our own equipment to demonstrate most of the phenomena in real life which the film shows in pictures. Again, the use of question slides or other topic tests prevent this review film becoming passive entertainment.

Films in any subject that have been used during the terms' work generally are good review devices if their showing is repeated again at the end of the term.

Do you now begin to conceive of the need for teacher-preparation, preview, selection, integration of film lessons? Dynamic mental activtiy is required of the skillful teacher who uses films! Films can thus never supplant the teacher from the classroom. In proper use they tend to overwork him!

A rough but usually obvious measure of any good teaching technique is the degree to which the students are stimulated in their attack upon the problems of the day's lesson. If a film, presented with adequate teaching technique does this better than the same grade of technique without the film,—then and then only are we justified in using the film.

Many of the errors in film-teaching technique are chargeable to organization and distribution of the films whereby films are available to the teacher only at arbitrarily scheduled intervals. It is our conclusion that the possible benefits that may result from the showing of a film out of proper sequence in an integrated lesson does not justify the inevitable disadvantages. And the greatest of these disadvantages of untimely showing is the pure entertainment or show attitude promoted in pupil minds.

With films like sermons,—almost "no soul is saved after the first twenty minutes". Mere footage is not valuable. The casual presentation of three or four reels at one sitting even if they are related titles can not compete with the neighborhood picture theatre and the comparison that pupil himself is apt to make, is odious

and even frequently boring to the child.

Free commercial films are seldom thrilling entertainment and yet the educational features are so sugar-coated they are often lost sight of. Many teaching films, we, in Rochester have come to earnestly desire in smaller pieces. If we could secure instructional motion picture films in 50 or 100 feet lengths, ofttimes we science teachers would appreciate the lightened encumbrance,—the relief, mechanically from handling the other 300 feet in the reel.

On the other hand, there is danger of error in this same direction. A teacher who uses only part of a film's possible contribution by presenting only one showing of a film very pertinent to the study unit, instead of a deferred repetition will forfeit further values obtainable from a second showing.

Teachers who fail to use the teaching manuals that accompany most teaching films, or who fail to preview an unfamiliar film before showing it to the class also commit grave errors of technique.

Another error is frequent. The use, by the teacher, of a manual as merely a synopsis to scan and present an outline to the pupils in advance of the showing of a film is practiced. By my observation, this procedure does little toward arousing the pupils' curiosity about, or providing resultant activity from the film presentation.

Failure to integrate the films with the local course of study is a common though more subtle error than failure to make advance planning and previewing of the film. Einstein's fourth dimension,—time, —is a factor in film-teaching not lightly to be conjured with. The radio broadcasting programs of the hour, such as *Town Meeting of the Air*, or *Professor Quizz* can demonstrate to teachers a thing or two about advance planning of time and the anticipated audience response.

A final error of technique is a program of supervision within a school system which does not stimulate a teacher to explore the manifold possibilities and the limitations of the film medium.

A BIBLIOGRAPHY OF AIDS FOR THE SCIENCE TEACHER

PAUL W. HEALY

Ohio Soldiers' and Sailors' Orphans' Home, Xenia, Ohio

Last year it was decided to offer a course in Senior Science in our school; I was selected to teach it. After investigating the available texts in the field, I decided that none of them met the needs of my group. Therefore, we dispensed with a regular text and decided to use instead the published bulletins of various commercial and industrial firms. I knew that there were many excellent booklets, charts, etc., in this field, but nowhere could I find any complete and modern bibliography on the subject. I do not believe that the bibliography submitted here is complete by any means. At least it is modern. Nothing is listed that is not absolutely free. From the booklets listed here I have built up a Senior Science course which has worked out very well.

The Bibliography is arranged by subjects, and the name and address of the publishing firm are given first, followed by the title or titles published by that firm, the number of pages, and a short discussion of the booklet or chart. In some cases the number of copies available are indicated.

TRANSPORTATION—THE AUTOMOBILE

General Motors Corporation, Customer Research Staff, Detroit, Michigan.

"Transportation Progress," 53 pp. The history of self propelled vehicles from the earliest times down to the modern motor car, with an appendix of Dates in the evolution of self

propelled vehicles. An interesting essay suitable for grades 9–12. Copies for each student are available.

"Putting Progress Through Its Paces," 32 pp. A beautifully illustrated story of the General Motors Proving Ground. The tests used to improve cars are described in non-technical language. Suitable for grades 9–12. Copies are available for each student.

"The Automobile Buyer's Guide," 80 pp. A well illustrated booklet outlining the things to be checked when buying a car. Contains "check sheets" on which several makes of cars can be compared. Also an excellent check on the mechanical equipment of any car. Best for grades 11–12. Copies for each student are available.

"The Story of Knee Action," 45 pp. A clear explanation of different types of knee action, with a discussion of the advantages and disadvantages of each type. Illustrated with sketches and diagrams. Suitable for grades 9–12. Copies for each student are available.

General Motors Corporation, Research Division, Technical Data Section.

"When the Wheels Revolve," or "Facts About the Automobile," 21 pp. A clear and very simple explanation of the operation of the mechanical parts of the auto. The diagrams are so good and the text so well written that even Junior high students can understand it. Suitable for grades 8–12. Copies for each student are available.

"Chemistry and Wheels," 21 pp. A well written and well illustrated booklet describing the manner in which the auto engine uses fuels, the composition of fuel, the products formed, and the uses of "Ethyl" in gasoline. Suitable for grades 9–12. Copies for each student are available.

"Diesel, the Modern Power," 31 pp. A clear and detailed explanation of the operation of the Diesel engine, with abundant diagrams. Also a short section on the uses of Diesel engines. Suitable for grades 9–12. Copies for each are available.

METALS AND METALLURGY

United States Steel Corp., Bureau of Safety, Sanitation and Welfare, 71 Broadway, New York.

"The Story of Steel," 63 pp. A well illustrated discussion of the manufacture of steel from its raw materials to finished products. The mining of iron ore and coal, the quarrying of limestone, the transportation of these materials to the blast furnace are discussed. The operation of the blast furnace, open hearth furnace, Bessemer converter, and electric furnace are described. Suitable for grades 10–12. Copies are available for each student.

American Steel and Wire Company, 208 LaSalle Street, Chicago, Illinois.

"Making Steel and Wire," 40 pp. A good discussion of various ore fields in the United States, with charts showing where ore is found. Description of blast furnace, Bessemer converter, and open hearth furnace. Explanation of wire making with numerous diagrams. This booklet contains quite a few technical terms, though not enough to discourage the better students. Suitable for grades 11–12. Copies are available for each student.

"The Experiences of an Iron Atom," 29 pp. An excellent account of an atom's eye view of the manufacture of steel. There are several technical terms and a few chemical formulas included. Probably a slight knowledge of basic chemistry would be necessary for a good understanding of this work. Suitable for grades 11–12. Copies are available for each student.

General Motors Corp., Research Laboratories Division, Technical Data Dept., Detroit, Michigan.

"Metallurgy and Wheels," 48 pp. A simple discussion of the metals used in automobile manufacturing, with emphasis on iron and steel. There is a short discussion of manganese, silicon, nickel, chromium, tungsten, molydenum, and vanadium, and alloy steels. Tempering, hardening, and annealing steel are briefly treated. There are many excellent diagrams and micro-photographs. Suitable for grades 9–12. Copies are available for each student.

A. M. Byers Company, P. O. Box 1076, Pittsburgh, Pennsylvania.

"The News Story of Ancient Wrought Iron," 16 pp. A well illustrated but brief account of the manufacture of wrought iron from pig-iron including descriptions of open hearth furnace and Bessemer converter. Suitable for grades 10–12. Only one copy is available.

Anaconda Copper Mining Co., Anaconda, Montana.

"Anaconda Reduction Works," 44 pp. An interesting and well illustrated account of the mining and refining of copper and zinc, also the preparation of the by-products of the refining process, sulphuric acid and phosphates. Suitable for grades 11–12. Several copies are available.

Kester Solder Company, Chicago, Illinois.

"Facts on Soldering," 33 pp. A brief and simple discussion of solders, fluxes, methods of soldering, etc. Numerous diagrams. Suitable for grades 9–12. Several copies available.

COMMUNICATION—TELEPHONE AND RADIO

The Bell Telephone Laboratories, 463 West Street, New York.

"The Magic of Communication," 38 pp. A clear and simple exposition of the operation of the modern telephone instrument and the modern telephone system, including radio telephone transmission. Maps, diagrams, and photographs add to the clarity. Suitable for grades 10–12. Copies are available for each student.

"Pictures from the Bell Telephone Laboratories," 48 pp. Excellent photographs of research projects of the Bell Laboratories, with simple accompanying descriptions. Suitable for grades 10–12. One or two copies obtainable.

"Through Electrical Eyes," 40 pp. By John Mills. An elementary exposition of the physics and chemistry involved in television, published in 1928 and therefore needs to be brought up to date. A clear and sound description of basic television principles. Suitable for grades 10–12. One copy is available.

Radio Corporation of America, RCA Building, 30 Rockefeller Plaza, New York, N.Y.

"Around the World Via RCA," 51 pp. A brief story of RCA communications, especially how to file cablegrams to all parts of the world. Gives a good non-technical survey of wireless in every country of the world. Suitable for grades 10–12. Several copies available.

"Via RCA," 35 pp. A description of the different uses of radio communication, including foreign service, marine radio, international broadcasting, advancement of radio communication, long waves, short waves, ultra short waves, etc. Quite a few technical terms. Suitable for grades 11–12. Several copies are available.

REFRIGERATION

Westinghouse Electric and Mfg. Co., East Pittsburgh, Pennsylvania.

"Ice by Wire," 20 pp. Ice and electric refrigeration compared by means of simple diagrams. All written in clear, non-technical language. Suitable for grades 8–12. Copies available for each student.

The Crosley Radio Corporation, Cincinnati, Ohio.

"Crosley System Chart." A 9" x 12" chart of the Crosley system much simplified. Done in five colors. No explanation of operation on chart. Suitable for grades 9–12. Several copies are available.

General Electric Co., Appliance and Merchandise Dept., Nela Park, Cleveland, Ohio.

"General Electric, CF Refrigerating Unit," 8 pp. Accurate description and photographs of important parts of General Electric Refrigerators. Some technical terms. Suitable for grades 10–12. Copies are available for each student.

Electrolux Refrigerator Sales Division, Evansville, Indiana.

"The Miracle of Ice from Heat," 27 pp. A really excellent discussion of the principles of gas refrigeration. Contains many good diagrams and photographs. Language is simple and clear. Suitable for grades 9–12. Copies are available for each student.

GLASS

Fostoria Glass Co., Moundsville, West Virginia.

"How Fostoria Glassware Is Made," 30 pp. An interesting description of the methods of glass manufacture, including pictures of various types of glassware. Suitable for grades 9–12. Several copies are obtainable.

Corning Glass Works, Corning, New York.

"The Many-Sidedness of Glass," 8 pp. by Eugene C. Sullivan. A fairly simple discussion of the use and properties of Pyrex ware as contrasted with ordinary glassware. Suitable for grades 11–12. One copy is obtainable.

"The 200 Inch Telescope Disc," 10 pp. by Dr. George V. McCauley. This paper deals with the general method employed for casting large telescope discs. Reasons for choice of the method are cited and technical details given. Suitable for grades 11–12. One copy is obtainable.

"Glass Characteristics," 3 mimeographed pages, by D. E. C. Sullivan. A good discussion of different types of glass, their properties and uses. Advantages of glass over metal for cooking are stressed. Suitable for grades 11–12. One copy is obtainable.

Plate Glass Manufacturers of America, First National Bank Bldg., Pittsburgh, Pa.

"Plate Glass," 20 pp. A brief discussion of the materials and methods of making plate glass, with a section on the uses of plate glass. Samples of rough, ground, and polished glass will be sent. Suitable for grades 10–12.

Bausch and Lomb Optical Co., Rochester, N. Y.

"The Use and Care of the Microscope," 31 pp. An excellent manual on the use of the microscope, dealing with all types of student microscopes and also research microscopes. There is a six page section on the theory of the microscope. Suitable for grades 10–12. Copies are available for each student.

LEATHER

The Ohio Leather Company, Girard, Ohio

"The Story of Leather," 80 pp. A photographic study of the manufacture of fine leather. The book takes the leather only

through the tannery, but is very complete in its description of this phase of the leather industry. Samples of leather are sent. Suitable for grades 9–12. Copies are available for each student.

PAPER

Kalamazoo Vegetable Parchment Co., Parchment, Michigan.

"The Story of Papermaking," 20 pp. Contains a 5 page historical note on paper making, a discussion of the materials used in paper making, and a description of the manufacture of paper. A chart to accompany the booklets is also available, which contains a complete account of paper making but must be studied at close range. Suitable for grades 10–12. Several copies are obtainable.

RUBBER

The Firestone Rubber Company, Firestone Park, Akron, Ohio.

"The Romance and Drama of the Rubber Industry," 132 pp. by Harvey S. Firestone, Jr. A splendid historical study of the rubber industry, this book deals far more with the history of rubber than the manufacture of rubber, which is discussed only incidentally. Suitable for grades 11–12. One copy is obtainable.

SUGAR

California and Hawaiian Sugar Corporation, Ltd., 215 Market St., San Francisco, Calif.

"Behind Your Sugar Bowl," 31 pp. Beginning with a short introduction and history, this book takes one through a modern sugar refinery by means of photographs and description. Suitable for grades 11–12. Several copies are obtainable.

The American Sugar Refining Co., 120 Wall Street, New York, N. Y.

"The Story of Sugar," (now out of print, but a new edition in on the presses). A history of ancient methods of sugar manufacture, followed by a description of plantation and sugar refinery. Suitable for grades 11–12. Several copies are available.

SALT

Diamond Crystal Salt Co., Inc., 916 S. Riverside Ave., St. Clair, Michigan.

"The Art of Seasoning," 24 pp. A brief discussion of 101 different uses of salt, in cooking, laundry, and about the house. Suitable for grades 9–12. Copies obtainable for entire class.

WEAVING

Bigelow-Sanford Carpet Co., Inc., 140 Madison Ave., New York.

"The Picture Book of Rug and Carpet Making," 62 pp. Large size, clear cut photographs tell every phase of the story of carpet making from raw wool to finished carpet. Descriptions are brief. Suitable for grades 10–12. One copy only is obtainable.

WATER SOFTENING

The Permutit Co., 330 W. 42nd Street, New York.

"Elements of Water Softening," an excellent but very technical discussion of the problems and methods of water softening. A demonstration water softener will also be sent on request. Suitable only for advanced 11–12 students. One copy obtainable.

MISCELLANEOUS SUBJECTS

The Barrett Co., 40 Rector Street, New York, N. Y.

Chart "The Products Derived from Coal," about 16 x 22 in. A splendid chart listing nearly all the products of coal distillation. The print ordinary book size type.

Corn Industries Research Foundation, 270 Broadway, New York.

"Corn in Industry," 62 pp. A book on the separation and uses of corn products, also a short discussion of corn production in this country. Well illustrated with photographs. Also accompanying chart, "Corn Refining Industry." Suitable for grades 9–12. Several copies are available.

Airtemp Incorporated, Dayton, Ohio.

Bulletins and booklets to describe summer and winter air conditioning. Much of the material is not directly useful. Suitable for grades 10–12. Copies of several booklets obtainable.

Sinclair Refining Co.

Sinclair Dinosaur Book, 13 pp. Describes and pictures six dinosaurs. Illustrations in color are excellent. Ask your Sinclair Dealer to supply you with copies.

And now a short final note: This bibliography is made up of *free* materials only. Many excellent exhibits and books of much value can be obtained from different concerns at a price, but these can be found listed elsewhere. It has been my experience in assembling this material that about one out of two concerns picked at random will have some material suitable for classroom use. All of the concerns listed above have been most courteous and cordial in their replies to requests for information and materials.

Digests of Unpublished Investigations

THE EXTENT OF ROTE LEARNING IN CERTAIN UNITS OF HIGH-SCHOOL PHYSICS

ALVIN WILLIAM SCHINDLER *

Problem.—"To secure a quantitative description of the extent to which pupils in high-school physics memorize textbook statements without grasping their meanings or developing understanding of related phenomena."

Method.—Statements of facts or principles in the subject matter of heat and electricity were selected from six textbooks of high-school physics on the basis of the following criteria:

Each statement of fact should make a definite contribution toward the achievement described by the objectives of instruction in high-school physics; that is, an understanding of the statement should result in a more intelligent attitude toward some significant aspect of the physical environment.

Most of the statements selected should appear in italicized or in bold-faced type.

From each unit of subject matter involved, enough statements should be chosen so that the test will provide a fairly intensive measure of the achievement in that unit.

The two types of test items, Type A and Type B, were constructed. Type A possessed these characteristics: Some items required the pupil to recall and to reproduce a textbook statement; others (direct questions) required the pupil to supply a single word or a number which he recalled in a textbook statement; certain ones required the pupil to select in a multiple-response item, the correct statement of a fact; certain others presented an incomplete textbook statement which the pupils were required to complete by supplying the missing word or phrase; and still others called for a short explanation, provided this explanation was stated briefly and with similar words in all six textbooks. "A common characteristic of all these Type-A items is that a pupil who has memorized the statements with which they are concerned may succeed in the items, even though his understanding of the statements is on a relatively low level. The common purpose of these items was to find how many pupils had *memorized* certain textbook statements, regardless of the degree of understanding they possessed."

Type B possessed these characteristics: Each item was directly related to a statement with which a Type-A item was concerned; some items asked the pupils to state in their own words what a certain word, phrase, or statement meant; others asked the pupils to recognize the correct meaning of a word, a term, or a statement when the meaning was expressed in a new or unfamiliar phrasing. Certain ones required the pupils to provide or to recognize in an unfamiliar form, the correct meaning of a word or phrase as it was used in a textbook statement; certain others asked the pupils to state or to recognize a correct explanation or interpretation (presented in unfamiliar form) of a given phenomenon; and still others required the pupils to state or to recognize a fact, and then to state or to recognize a reason why the fact is true. "A common characteristic of these items is that they cannot be answered simply by supplying or recalling a stereotyped textbook statement. To succeed in these items the pupil must recognize the idea of the original statement when presented in a different and often unfamiliar form, use the idea in explaining or interpreting a phenomenon, or describe the meaning of the crucial words in the original statement. The common purpose of these items is to determine the extent to which the pupils understand the statements on which the Type-A items are based."

Of the seven tests used, respectively three and four tested knowledge and understanding of *heat* and of *electricity*. The tests were administered as soon as the work on each unit had been completed. The tests were administered to approximately three hundred pupils in 34 Iowa schools selected at random. Scoring was done so that tabulations could be made on a Hollerith machine. Reliability coefficients were computed on half of each test by the chance-halves method; and then for the whole test by using Brown's Formula. All the coefficients of reliability of the seven tests ranged from $.862 \pm .009$ to $.925 \pm .005$.

In analyzing the data ". . . the pupils who wrote each test were divided into 10 'ability' groups according to their total scores on the test."

Findings.—1. "The average number of correct answers to the Type-A items was from 50 per cent to 60 per cent higher than the average number of correct responses to the Type-B items."

2. "The extent of rote learning was much more pronounced in the low-ability groups than

* Unpublished dissertation for the degree of Doctor of Philosophy, Iowa State University, 1934.

in the high-ability groups, but there was a significant amount of rote learning at all levels of achievement."

3. "The pupils who gave the correct responses in the Type-A items were more able to succeed in the Type-B items than the pupils who were not able to recall the statements on which the Type-A items were based."

Conclusions.—1. "Stereotyped textbook statements in the subject matter of high-school physics are memorized, on the average, by about 70 per cent of the pupils, but only 17 per cent of all the pupils develop a 'satisfactory' understanding of these statements. Of the pupils who memorize the statements, approximately 25 per cent develop a satisfactory understanding of them. Approximately 50 per cent of the pupils who are able to recall a textbook statement are able to show an understanding of the statement by succeeding in a single test item that presents the statement in an unfamiliar form, or that requires use of the statement to explain a phenomenon. These findings are particularly significant in view of the fact that the items used to determine whether or not the pupils had a 'satisfactory' understanding were quite simple and closely related to the explanations given in the textbooks."

2. "If achievement in high-school physics is measured with tests that require only the recall of textbook statements in their familiar phrasings, the test results greatly exaggerate the achievement which the pupils have actually attained, because many pupils succeed in these tests by repeating or recognizing statements which they do not understand. Likewise, if the class recitation is concerned chiefly with the repetition of textbook statements, the teacher cannot tell whether or not the pupils have developed or are developing the understanding which they need to develop, if the statements are to serve them in the situations and for the purposes described by the objectives of instruction."

Abstracts

SECONDARY SCIENCE

PRESTON, CARLETON E. "Objectives and Practices." *High School Journal* 21: 266–271, 278; November, 1938.

"Today's literature on science teaching . . . is full of attempts to set down . . . objectives . . . . Unfortunately when teachers return . . . to their classrooms . . . these objectives are all too soon forgotten." Illustrations are given to suggest that content which is supported in terms of some of these objectives may not be functioning as expected.

—O. E. Underhill.

DOANE, DONALD C. "What I Want From the Producer of Educational Films." *The Educational Screen* 17: 257–259, 274; October, 1938.

An excellent analysis of the difficulties which arise in attempting to plan science units to make effective use of available films. The well-made educational films cover a very small part of the field and appear more suited to college than to secondary or junior-high level. The commercials do not bring out the points desired by the science teacher.

—O. E. Underhill.

SIMMONS, MAITLAND P. "Changing Conceptions of Dominant Problems Relating to Major Topics in General Science Textbooks." *Journal of Experimental Education* 6: 399–405; June, 1938.

This article presents a summary of an analysis of eighteen general science textbooks published from 1911 through 1934. A table summarizes the findings on the following sixteen major topics: (1) air, (2) animal life, (3) electricity, (4) energy, (5) forces of nature, (6) health, (7) heat, (8) light, (9) machines, (10) matter, (11) planets, (12) plant life, (13) soils, (14) sound, (15) water, and (16) weather.

—C.M.P.

LATON, ANITA D. "Approaches to Sex Education in the Schools." *University High School Journal* 16: 147–155; April, 1938.

In general, sex education in schools has developed along two lines: study of the biology of reproduction and study of personal relationships. Quite recently, a third approach has been attempted in a few places, emphasizing individual development and all that it may mean for the happiness and success of the students' personal lives. The author discusses the limitations and advantages of these three approaches to the problem.

—C.M.P.

VORHEIS, E., LELAND, E. B., MASON, C. V. and HUNT, HELEN. "Studying Communicable Diseases in the High-Eighth Grade." *University High School Journal* 16: 137–140; April, 1938.

This is a description of a unit on communicable diseases developed in the high-eighth grade science class at the Claremont Junior High School. Subtopics are: (1) the history of disease, (2) the cause of disease, (3) how disease spreads, (4) cleanliness as an aid to prevention, (5) antiseptics—their uses and harms, (6) toxins and anti-toxins, (7) endemic and epidemic diseases, (8) children's diseases—what we should know about them, (9) the future of disease and (10) summary with a list of common sense rules regarding personal health.

—C.M.P.

FRANK, J. O. "What Ought to Be the Content of Health Materials in High-School Chemistry Texts?" *Journal of Chemical Education* 15: 532–536; November, 1938.

The author analyzed ten high school chemistry texts published since 1931 to determine the amount and kind of health material included. The material on health was found to be small, inadequate and often incorrect and misleading. The author outlines the type of material that he believes should be included. This relates primarily to new material which would tend to reduce the high mortality from accidents in which chemicals play a part.

—C.M.P.

WEBB, MAHLON R. and WILSON, STERLING O. "Lantern Slides of Cellophane." *Educational Screen* 17: 43–44; February, 1938.

Brief suggestions for making hand-made lantern slides and ways of using them in effective teaching.

—O. E. Underhill.

SYMPOSIUM. "Science Clubs." *Science Leaflet* 12: 1–15; September 22, 1938.

This issue of *Science Leaflet* includes material on: (1) how to affiliate, (2) how to organize a club, (3) typical constitutions, (4) club-activities, (5) trips, and (6) science fairs. The latter includes a great variety of interesting things a science club may do.

—C.M.P.

SIGLER, H. "The Fable of the Calimyrna Fig." *Biology Briefs* 1: 52–53; October, 1938.

This is an interesting story of how the pollination of the fig was discovered.

—C.M.P.

GLUCK, HAROLD. "What Students Want to Learn in Consumer's Education." *The Teach-*

ing Biologist 8: 1–6; October, 1938.

The following topics were those about which 120 girls in a New York City high school desired information: (1) advertisements and the labeling of products; (2) organizations, protection and literature devoted to the consumer, (3) cosmetics and medicines, (4) food, (5) running the house, household appliances, and clothing, and (6) market factors.

—C.M.P.

VAN VEEZER, H. L. "A Penny." *Science Leaflet* 12: 9–17, 21–31, 13–22, 20–32, 12–22; September 29, October 6, October 13, October 20, 1938.

This is an unusually good series of articles relating to our present day concept of the structure of matter and the atom.

—C.M.P.

FOX, JESSE G. and MARGOLIES, EMANUEL E. "Photography Club." *The Clearing House* 12: 538–539; May, 1938.

The activities of the Photography Club of the Patrick Henry Junior High School, New York City, are described in this article. Interest and enthusiasm of the club members have been unusually high.

—C.M.P.

HITCHINGS, J. M. "Observational Bee Hive in the Biology Laboratory." *The Iowa Science Teacher* 4: 43–46, 54–55; May, 1938.

This article describes the author's experiences with a bee hive in the science laboratory of the senior high school of Davenport, Iowa. A method of installing and caring for such a bee hive is described. Thirty-nine questions on bees and their activities are included.

—C.M.P.

SIGLER, H. "Some Notes on the Carnivorous Plants Found in the United States. Part 2—Sundew, Venus's Flytrap." *Biology Briefs* 1: 41–43; September, 1938.

This article describes the habitats and physiological reactions of a few carnivorous plants.

—C.M.P.

LYONS, W. JAMES. "Inaccuracies in the Textbook Discussions of the Ordinary Gas Laws." *The American Physics Teacher* 6: 256–259; October, 1938.

Strangely enough there exists great confusion as to whom should be credited with the gas law stating "the volume of a gas is proportional to absolute temperature the pressure being constant,"—whether Charles or Gay-Lussac. (Abstractor's note: Even such writers as Timm seem to be confused and high school and college textbooks in physics and chemistry sometimes give one, sometimes the other credit.) The author adduces evidence supporting the viewpoint that Gay-Lussac should be assigned major credit for the law so often bearing the name of Charles.

—C.M.P.

GLASOE, P. M. "The Present High School Course in Chemistry—A Paradox." *Journal of Chemical Education* 15: 364–367; August, 1938.

The two main causes for the failure of high school chemistry are (1) it is too massive (2) the course starts out as if it expected to make chemists of all boys and girls taking it. The content of high school chemistry does not correlate with the stated objectives of secondary education. The author makes a plea for a cultural course in high school chemistry that "will prepare both for college and for life."

—C.M.P.

JAFFEE, BERNARD. "The History of Chemistry and Its Place in the Teaching of High School Chemistry." *Journal of Chemical Education* 15: 383–389; August, 1938.

In the opinion of the author much more history of chemistry should be introduced into the high school chemistry course. A course in the history of chemistry should be a required college course for every chemistry teacher. Secondary textbooks should include much more such material.

—C.M.P.

WEAVER, ELBERT C. "It's a Great Course If You Can Get It." *The Science Leaflet* 12: 34–40; September 15, 1938.

This is a dramatics sketch suitable for a student assembly. The sketch has a "chemical" flavor but will appeal to a non-chemical audience.

—C.M.P.

WAILES, RAYMOND B. "Weird Lights and Cold Flame." *Popular Science Monthly* 133: 74–75, 102–103; July, 1938.

This illustrated article describes several interesting experiments that may be performed with phosphorus. —C.M.P.

WAILES, RAYMOND B. "How to Analyze Foods in Your Laboratory." *Popular Science Monthly* 133: 206–209, 244; October, 1938.

Laboratory procedures for chemical analysis of foods in high school chemistry laboratories are given in this illustrated article.

—C.M.P.

WAILES, RAYMOND B. "Home-Laboratory Tests with Alcohol." *Popular Science Monthly* 133: 216–219, 250; November, 1938.

Several interesting laboratory experiments with alcohol are described. —C.M.P.

WALLING, MORTON C. "Life in a Leaf." *Popular Science Monthly* 133: 220–223, 252; November, 1938.

Instructive experiments of life in a leaf that may be seen through a microscope are described.

—C.M.P.

SCIENCE

IVES, RONALD L. "Seeing the Invisible." *Science News Letter* 34: 218–220; October 1, 1938.

A generation ago Dr. Abbe Zeiss, microscope expert, set 1,500 diameters as the limit of magnification, and more recent mathematicians agreed with him. But Dr. L. C. Graton of Harvard has built a super-microscope givnig magnifications of 6,000—roughly equivalent to enlarging an air mail stamp to eight acres. This new microscope is constructed as ruggedly as a locomotive. So sensitive is the adjusting mechanism that it would take a fast man, turning the controls by hand, seven minutes to move the lens one hundredth of an inch. The possible uses of this new tool of science would appear to be exceedingly great.

—C.M.P.

ANONYMOUS. "Our Galaxy Biggest Known." *Science News Letter* 34: 3; July 2, 1938.

Our galaxy, the biggest known to astronomers at present, is 100,000 light years in thickness. The rotational speed of the galaxy in the vicinity of the sun is about 175 miles a second, but so vast is the system that it takes 220,000,000 years to complete one rotation. The total mass of the system is 165,000,000,000 times that of the sun. The spiral nebula in andromeda is only slightly less large than our own galaxy.

—C.M.P.

COLNAT, ALBERT. "Epidemics That Changed History." *Science Digest* 4: 1–6; July, 1938.

This article is translated and condensed from the book *Les Epidemies et l'Histoire*. Epidemics, much more prevalent in the past than in recent times, have literally wiped out entire cities. Bubonic plague or Black Death in the middle of the fourteenth century killed between 30 and 40 million Europeans and an equal number of Chinese and Asiatics. Cholera, typhus, yellow fever, measles, syphilis and influenza have been other epidemic diseases exacting an appalling toll of lives. —C.M.P.

ANONYMOUS. "Human-Like Tracks in Stone Are Riddle to Scientists." *Science News Letter* 34: 278–279; October 29, 1938.

Science is faced with the puzzling question "What was it that lived 250 million years ago, and walked on its hind legs, and had feet like a man?" Such footprints have been found in sandstone near Berea, Kentucky. The footprints are the right size—nine or ten inches—to be human and they are almost the right shape—except for the shape of the big toe and the right-angled little toe. —C.M.P.

ANONYMOUS. "Scientists Seek to Simplify World's 2,000 Color Names." *Science News Letter* 34: 319; November 12, 1938.

Some 2,000 names designated for color have been reduced to 320. Eight adjectives—strong and weak, light and dark, and pale, deep, dusky, and brilliant—are applied to each hue. The agreed upon names are: pink, orange-pink, red-orange, red-brown, orange, brown, yellow-orange, yellow-brown, yellow, olive-brown, olive, yellow-green, green-olive, green, blue-green, blue, purple-blue, purple, purple-pink, red-purple, white, grey, and black. —C.M.P.

LODGE, JOHN E. "New Oil Sources Forecast by World's Deepest Well." *Popular Science Monthly* 133: 21–23; August, 1938.

Near Wasco, California, has been drilled recently the deepest hole in the earth—an oil well 15,004 feet deep. It has a temperature of 270 degrees at the bottom. In 1915 drillers sent a well at Charleston, South Carolina, to what was then a world-record depth—2,000 feet. Electric probes are used to detect oil. A kind of a "machine-gun" fires bullets to start the flow of oil. —C.M.P.

EDDY, FREDERICK B. "The Panther on the Hearth." *The National Geographic Magazine* 74: 589–634; November, 1938.

This is an article on cats with 22 illustrations and 25 natural color photographs by Willard D. Culver. The cat is described as "the only domestic animal man has never conquered." Many interesting facts about this common pet are related. The photographs are striking.

—C.M.P.

RUSSELL, HENRY NORRIS. "How Hot Is the Sun?" *Scientific American* 159: 126–127; September, 1938.

The sun has no single temperature but the layer that sends us light directly averages about 9,873 degrees Fahrenheit.

—C.M.P.

ANONYMOUS. "Man-Made Diamonds." *Scientific American* 159: 178–179; October, 1938.

The first experiments to produce synthetic diamonds were made in 1879 by J. B. Hannay of Glasgow. However, the most successful early attempts were those by Henri Moisson in 1896. In recent years Dr. J. Willard Hershey of McPherson College has carried on seemingly successful experimentation using temperatures of 4,000 degrees and 90 tons pressure per square inch. —C.M.P.

VOKES, H. E. "The Mapping of Ancient Seas." *Natural History* 42: 170–184; October, 1938.

This illustrated article relates and illustrates how the geologist reconstructs the scene of prehistoric "cataclysms" that radically changed the face of the earth and re-creates the animals that struggled and died beneath long-vanquished seas. The accompanying maps and photographs are unusually good. —C.M.P.

LEY, WILLY. "The Story of the Lodestone." *Natural History* 42: 201–207; October, 1938.

This article relates the early history of magnetism and the story of the present day alloy magnets that are unusually powerful.

—C.M.P.

ANONYMOUS. "Lightning-Dodgers of the Forest." *Popular Mechanics Magazine* 70: 690–693, 134A–136A; November, 1938.

This describes the ways in which the forest fire lookouts must protect themselves from the high static charges which develop about their lookout stations. Methods of finding forest fires and how the fire fighters are mobilized to control them are given. An interesting device by which the humidity is measured is described.

—O. E. Underhill.

ANONYMOUS. "New Oil Wells From Old Ones." *Popular Mechanics Magazine* 70: 641–643, 149A–153A; November, 1938.

A method is described by means of which pores in oil bearing limestone are enlarged by use of acid. An inhibitor prevents the hydrochloric acid from attacking the metal pipe and drill parts. By this means the gas, which is so important in forcing the oil from the well, is conserved. This method can be used so as to increase or decrease gas pressure, increase or decrease the gas-oil ratio, and increase or decrease the oil-water ratio at will. To date, 25,000 oil wells in different sections of the country have been acidified. Further retails as given in this article are very interesting.

—O. E. Underhill.

ANONYMOUS. "The Truth About Tank Farming." *Popular Mechanics* 70: 232–235, 118A–119A; August, 1938.

This article brings out that the recently much publicized practice of growing plants in nutrient solution is neither new nor a revolutionary discovery, but rather the application of a laboratory research technique on a commercial scale. Although there is considerable experimentation, the tomato is about the only crop now grown by water-culture commercially and only a few such greenhouses are operating. The cost of equipment and operation at present tend to limit this method of plant cultivation to high priced crops grown out of season. Proper control of the mineral composition of the nutrient solutions requires expert and detailed care. Other interesting details of this development are given in the article. —O. E. Underhill.

REYNOLDS, DANIEL. "Photomicrographs Through a Mailing Tube." *Popular Mechanics* 70: 291–293; August, 1938.

Details are given for extending the distance from lens to film of an ordinary camera by using a mailing tube. Using a 13.5 cm. lens with a f.4.5 aperature, a magnification of about ten may be obtained.

—O. E. Underhill.

ANONYMOUS. "The Age of Color." *Popular Mechanics* 70: 489–496, 128A–129A; October, 1938.

Well presented spectrum charts and theory of color tied in with the use of color in various industries are presented in this article. The use of color in many products seems to increase their sale markedly. Several examples are given of the use of color in manufacturing processes with brief suggestions as to devices for testing and matching the pigments. The color spectrum is shown in relation to the complete electromagnetic spectrum and the radio section of this spectrum is expanded to show the way in which the various wavebands are allotted for different uses. —O. E. Underhill.

ANONYMOUS. "Measuring Distances with This Simple Sextant." *Popular Mechanics* 70: 441–442; October, 1938.

Detailed plans for constructing a simple sextant which may be used in measuring distances or altitudes of the sun and other heavenly bodies are presented. —O. E. Underhill.

ANONYMOUS. "Dispatching on the Underground Railways." *Popular Mechanics* 70: 530–533, 144A–146A; October, 1938.

This article vividly describes how the flow of oil through thousands of miles of underground pipe is controlled. Some of these pipes may be carrying a dozen shipments of oil of different grades, one behind the other, to be diverted at various points to scattered locations. The end of each lot is marked with a colored dye so it may be recognized by the switchman. Many problems of viscosity and its relation to density and temperature must be kept in mind in order that the dispatcher may make up a time table of his shipments. Over a million miles of such pipe lines are in operation in the United States —four times as much as the total railroad trackage. The article gives many interesting details involved in this method of transporting fuel oil. —O. E. Underhill.

ANONYMOUS. "New Drills Promise to Bore Miles into Earth." *Popular Mechanics* 70: 562–563; October, 1938.

This is a brief account with an excellent diagram of cross-section of an oil well, of a new type of drill designed to go deeper than is now possible. It is believed that the limit has about been reached through applying power at the top of the rod attached to the bit. Interesting diagrams show graphically the immense weight of the drill equipment which must be operated in present deep wells. The procedure for the future seems to lie along the line of applying power at the bit itself. Two methods are suggested: (1) by using an electric motor at the bit, supplied by a cable, or (2) embodying a turbine in the bit, operated by some fluid sent through a hollow shaft. Neither of these methods has yet reached the practical stage.

—O. E. Underhill.

Crowley, C. A. "Choke Coils Control Voltage in A. C. Apparatus." *Popular Mechanics* 70: 627–631; October, 1938.

This will prove extremely valuable to any physics teacher who desires to carry on advanced construction projects in the laboratory with his students. Detailed instructions are given for constructing such choke coils. Tables and curves are given so that necessary data may be easily obtained for building a coil for any specific purpose. —O. E. Underhill.

Lillie, Frank R. "Zoological Sciences in the Future." *Science* 88; July 22, 1938.

This article discusses the evaluation of zoological theory, the development of techniques, zoology and cultural development, and zoological sciences in the future. —C.M.P.

Rayleigh, R. T. "Vision in Nature and Vision Aided by Science; Science and Welfare." *Science* 88: 176–181, 204–208; August 26 and September 2, 1938.

This is the address of the President of the British Association for the Advancement of Science. In this address Lord Rayleigh says science is used but not heeded. "The world is ready to accept the gifts of science to use for its own purposes, but it is difficult to see any sign that it is ready to accept the advice of scientific men as to what those uses should be." He maintains that science is not responsible for the application of its own discoveries to the purposes of war. —C.M.P.

Compton, Arthur H. "Physics and the Future." *Science* 88: 115–121; August 5, 1938.

Possible future trends in the development of physics are pointed out. Important fields to be investigated include all sources of energy, communication, structure of matter, low and high temperatures and the physical universe. —C.M.P.

Urey, Harold C. "Chemistry and the Future." *Science* 88: 133–139; August 12, 1938.

The trends of chemical discovery both in the theoretical and practical fields are discussed. New discoveries and new theories are impossible of prediction. Advances will be made in both areas but no one is able to predict exactly what the advances will be. —C.M.P.

Darwin, Charles Galton. "Logic and Probability in Physics." *Science* 88: 155–160; August 19, 1938.

This is the concluding portion of the address of the president of the section of mathematical and physical science of the British Association for the Advancement of Science. —C.M.P.

Barrons, Keith C. "Modern Plant Wizardry." *Scientific American* 159: 14–17; July, 1938.

In maintaining and improving plant heritage, persistence and patience, not magic, gets results. Plant breeding involves more than cross-fertilization of different individuals. Selection of individuals is the basis of all plant-breeding work. —C.M.P.

Ives, Ronald L. "Mining a Mountain." *Science News Letter* 34: 186–188; September 19, 1938.

The world's chief source of molybdenum is Bartlett Mountain in Colorado, a bleak, isolated mountain once cursed because it held no gold. The article relates how the use of molybdenum has been steadily increasing and also describes the tedious mining and refining processes. In 1936 Bartlett Mountain produced 15,000,000 pounds of concentrates, about three-fourths of the world's output. —C.M.P.

Brown, Robert M. "The New England Hurricane." *The Journal of Geography* 37: 294–300; November, 1938.

This is a discussion of the hurricane which passed over New England on September 21—the most destructive storm in all New England's history. This storm was caused by unusual, unpredictable atmospheric conditions. The article is illustrated. —C.M.P.

Symposium: "The Atmosphere." *The Science Leaflet* 12: 1–16; November 3, 1938.

This material on the atmosphere includes a discussion on the New England hurricane, history of our knowledge of air, and a number of short, interesting articles about air. —C.M.P.

LaMer, Victor K. "Newer Concepts of Acids, Bases and Salts." *Science Leaflet* 12: 2–7; October 13, 1938.

This is abstracted from the Priestly Lecture at the Pennsylvania State College. This is an excellent article for those desiring a simple, modern idea as to what acids, bases and salts are according to chemists. —C.M.P.

Lathe, Frank E. "World Natural Resources." *Science* 88: 337–344; October 14, 1938.

The Malthus theory, enunciated 140 years ago that the human population would increase more rapidly than food production, has not been realized nor is it likely to be anyways soon. The greatest probable future lack is in fuel, power, and minerals. The United States is unusually fortunate here. It has 9 per cent of the world's forest areas, half of the world's coal, sufficient iron, aluminum and most minerals except tin, nickel and asbestos. —C.M.P.

Hixson, A. W., and Rogers, Raymond R. "Production of Chemicals by Minute Organisms." *Journal of Chemical Education* 15: 357–362; August, 1938.

Many important chemical reactions are initiated by living organisms. Among these reactions are those in vinegar making, souring of milk, nitrogen-fixation, bread making, and butanol-acetone-ethanol manufacture. —C.M.P.

New Publications

Eckels, Charles F., Shaver, Chalmer B. and Howard, Bailey W. *Our Physical World.* Chicago: Benjamin H. Sanborn and Company, 1938. 801 p. $2.20.

Our Physical World is designed for use in the eleventh and twelfth grades. It comprises an integrated course in physical science for the upper high school levels, similar to the survey courses in physical science now commonly offered in liberal arts and teachers colleges in the freshman year. This is the second text to appear in this field. The authors, instructors in the physical science department of the Pasadena Junior College, have done an excellent job in presenting an integrated course, emphasizing fundamental concepts of energy and matter, the growth of scientific knowledge, and man's economic and social use of science.

The unit technique is utilized, there being twelve units in all. Units have a preview and include an interpretation and review, list of outcomes, understandings and meanings, attitudes and appreciations, techniques and skills, student activities (in the laboratory), study questions, topics for special reports, suggestions for teachers (visual aids, references, suggested demonstrations), and bibliography. The 436 photographs and illustrations are very good. The reviewer believes that such a course is preferable to the physics and chemistry courses now offered, but that such a course to be adequately presented will require better trained teachers of physical science than we now have. —C.M.P.

Jacobs, Morris J. *The Chemical Analysis of Foods and Food Products.* New York: D. Van Nostrand Company, Inc., 1938. 537 p. $6.00.

The author states that the primary objective of this treatise is "to give systematic coverage to the salient facts of the chemical analysis of foods and food products and to include certain of the newer aspects of food analysis." The latter phase includes gums, jams, and jellies, milk products, soy bean flour in meat, pumped smoked meat, etc. While the book is of more value to the commercial or college chemist, the high school chemistry teacher will find it a most useful handbook. The following topics are considered: (1) general methods, (2) physical chemical methods, (3) coloring matter in foods, (4) preservatives in food, (5) metals in food, (6) milk and cream, (7) milk products, (8) oils and fats, (9) sugar foods and carbohydrates, (10) gums, cereals, starch and other polysaccharides, (11) jams, jellies, fruits, (12) spices, flavors, condiments, (13) non-alcoholic beverages and allied products, (14) alcoholic beverages, (15) meat, meat products, fish and eggs, (16) vitamins, and (17) inorganic determinations. —C.M.P.

Anonymous. *Glyco Cosmetic Manual.* New York, 148 Lafayette Street: Glyco Products Company, Inc., 1938. 91 p. $0.25.

This small handbook includes directions for making a variety of cosmetic products. High school chemistry teachers will find the manual quite useful. —C.M.P.

Weingart, George W. *Dictionary and Manual of Fireworks.* Boston: Bruce Humphries, Inc., 1937. 170 p. $3.00.

This is a book that many science club sponsors and chemistry teachers will appreciate. The author is a fireworks' manufacturer in New Orleans and an authority in this field. Recipes and method for every known pyrotechnical article in large and small quantities are included. The author stresses the need for scientific and safe handling of the materials.

Materials and methods used in making colored fires, smoke, smoke screens, water fireworks, sparklers, colored flames, stars, rockets, torches, etc., are included. —C.M.P.

Johnson, B. Lamar. *What About Survey Courses?* New York: Henry Holt and Company, 1937. 377 p. $2.85.

This is a book dealing with the philosophy, content, administration and evaluation of survey courses in colleges. The major divisions of the book are: (1) general aspects and problems, (2) curricula in specific colleges and universities, (3) survey courses in the natural sciences, (4) survey courses in the social studies, (5) survey courses in the humanities, (6) composite survey courses, and (7) measurement and evaluation.

The part dealing with survey courses in the natural sciences seems especially pertinent and well done. The chapters and authors are: (1) "Characteristics of Science Survey Courses" by Robert J. Havighurst, (2) "Survey Courses in Science as Agencies of General Education" by Samuel Ralph Powers, and (3) "General Education and the Physical Science Survey Course" by Frederick L. Hovde.

Due to the dearth of printed material on survey courses this book is especially timely. Survey courses represent the greatest innovation in college teaching in decades and there seems little doubt but that they have come to stay. —C.M.P.

Clark, Leonard. *A Wanderer Till I Die.* New York: Funk and Wagnalls Company, 1937. 246 p. $3.00.

This is a volume of loosely hung together

travel tales. This book has little more plan than the wanderings of the author. It deals with travel in China, Japan, Java, Borneo, and Mexico. It is entertaining reading. Any one of the tales is likely to be a thriller. It makes little difference which chapter is read first. For whiling away an hour or so beside a winter fire the book provides entertaining vicarious adventuring. For useful geographical and scientific information there is little to recommend it.

For people concerned in building up school libraries, there are a great many books that might be placed ahead of this one on the library lists. —R.K.W.

HANSON, EARL PARKER. *Journey to Manaos.* New York: Reynal and Hitchcock, 1938. 342 p. $3.00.

This is a highly entertaining travel and adventure story. It tells of the journey of the author through Venezuela and Brazil on the Orinoco and the Rio Negro to Manaos. Manaos is the capital of Amazonas Province in Brazil and lies on the Rio Negro twelve miles above its junction with the Amazon.

The author made his journey to resurvey stations located to get information concerning terrestrial magnetism for the Carnegie Institution of Washington, D. C.

The journey was made through jungle regions little known to most readers in the United States. It is a thrilling, unexaggerated tale of adventurous travel. Sometimes the reader wishes that the author could give more space to the people and the region in which he traveled and less to details of South American politics, revolution, and rebellion.

Most of us know too little of South America. This book can help to dissipate this ignorance in a highly entertaining fashion. The book is recommended for senior high school or junior college age students rather than for those younger. —R.K.W.

HARRISON, TOM. *Savage Civilization.* New York: Alfred A. Knopf, 1937. 461 p. $4.00.

The author, a biologist and anthropologist, was born in 1911. He was educated in the English Universities. He went on a university expedition to Lapland in 1930; led one to St. Kilva, another to central Borneo and this one to the New Hebrides. It is of these islands that he writes in the present volume. It tells of the customs and beliefs of the natives before the advent of the whites, of the changes produced by the Spanish explorers, the English and French rulers, the American whalers, a variety of missionaries. One reads with shame of the things our vaunted superior civilization imposed on the natives of these islands—slavery, seduction, pestilences, firearms, firewater, rival sectarianism. The book is an unbiased presentation of facts. It is not only fascinating reading but, particularly valuable to the historian and the anthropologist. The decimation of the native populations of the several islands by measles, whooping cough, tuberculosis and other diseases of civilized communities provides some appalling statistics. —E.R.D.

NATIONAL EDUCATION ASSOCIATION. *Addresses and Proceedings of the 1938 Meeting of the National Education Association.* Washington, D. C.: The Association, 989 p.

More than 200 addresses on various educational topics are abstracted. There are 16 on health education, 5 on other phases of science instruction. The titles of two of these are significant as indications of modern trends: "Some Aids in Reflective Thinking" and "The Emphasis of the Science Program Shall Be Placed on Principles." —E.R.D.

ROGERS, FRANCES and BEARD, ALICE. *5000 Years of Glass.* New York: Frederick A. Stokes Company, 1937. 303 p. $2.50.

A well illustrated history of glass making and a description of some of the various types of glass ware. The collector of antiques will enjoy the book as will the housekeeper who possesses some valued heirlooms of old glass. There is an interesting chapter on stained glass windows. The modern uses of glass in miscroscope and telescope lenses and in the great 200-inch mirror for the Mount Palomar telescope are simply described. Probably the scientifically minded individual will prefer to read of such in some recent book on optics. —E.R.D.

FURNAS, C. C. and FURNAS, S. M. *Man, Bread and Destiny.* New York: Reynal and Hitchcock, 1937. 364 p. $3.00.

In the first place this is another Furnas book. Those who read *The Next Hundred Years* will want to read this one also. In this case, the author's wife, a former teacher of nutrition in the University of Minnesota, has collaborated in the production.

The book is authentic, readable, amusing, and entertaining. The nutrition expert will chuckle over it. The layman will read it with profit. There is much of the history of nutritional knowledge, many amazing tales, scathing criticisms, and finally a summary of existing nutritional information.

The book is recommended to teachers, high school and college students, and to laymen in general. It should be required reading for all who are inclined to be food faddists. —R.K.W.

CARLSON, FRED A. *Geography of Latin America.* New York: Prentice-Hall, Inc., 1937. 642 p. $4.00.

Latin America includes South America, Mexico and the West Indies. This is one of the most complete geographies of this region that has been published, a real compendium of knowledge in its twenty-three chapters. There are 200 maps and illustrations. The type is larger than average and the style pleasing, making it a very readable textbook. The photographs are fairly well

selected and for the most part distinct. If a textbook or source of information on Latin America is desired, it would be difficult to find a better book. With present world conditions as they are, coupled with an unusual desire to know and understand our southern neighbors better, this book is quite timely. —C.M.P.

PARKINS, A. E. *The South and Its Economic-Geographic Development.* New York: John Wiley and Sons, Inc., 1938. 528 p. $4.00.

This volume is an attempt to describe the civilization of the South, mainly its economic-geographic aspects. It is written for the general reader and is presented scientifically and without bias.

Economically, the region is pictured as a land of great natural resources, as yet only barely touched. As far as soil and climate are concerned, the south still has great possibilities agriculturally. Education is a force of prime importance here. Manufacturing, including textiles and chemicals, has made only a beginning. The region is rich in power resources—whether one considers water, petroleum, or coal. As a paper manufacturing center there would seem to be ample resources to supply the nation.

With all of these resources one wonders why the South has not made more progress than it has. There are several reasons, among which lack of education is preeminent, but rapid strides are being made here. There has been lack of capital and a feeling of reluctance toward outside capital coming in. But no other region in the United States offers as promising prospects as does the South. —C.M.P.

HORTON, RALPH E. *Modern Everyday Chemistry.* Boston: D. C. Heath and Company, 1937. 451 p. $1.68.

The author, chairman of the Department of Science at Seward Park High School, New York City, states that "this book is not an encyclopaedia of chemistry, nor a cookbook, nor an industrial chemistry, nor an agricultural chemistry—the point of the book is that the study of chemistry may contribute to the understanding of the world and of human affairs."

The textual material is built around five units of 32 chapters. The units are: (1) oxidation in a world of change, (2) reduction, (3) fuels and energy, (4) water and its relation to chemical change and (5) chemistry and human affairs. Each chapter is preceded by a statement of "Problems," a list of topics for "Class Investigations," and a "Foreword." At the close of each chapter is a "Summary of Principles," "Questions," and "Problems for Investigations." At the end of each unit is a list of books suitable for reading and reference.

The print is most readable and the diagrams and photographs are clearcut. Altogether one may readily say that this is one of the better chemistry textbooks—at least among the best three or four. —C.M.P.

HORTON, RALPH E. *Laboratory Manual in Chemistry.* Boston: D. C. Heath and Company, 1937. 99 p. $1.00.

This is a manual designed to accompany the author's *Modern Everyday Chemistry.* In the preface the author states that "this manual provides a program of activities for (a) learning the principles of chemistry and (b) acquiring training in scientific methods—if five days are used for chemistry, one day should be demonstration and two days individual laboratory work. The other two days should be devoted to discussion, recitation, and learning of principles from the textbook."

The first 82 experiments are the general ones found in most laboratory manuals; then follow 11 experiments on methods of testing foods for adulterants and preservatives, 7 on cleaning and sanitation, 11 on textiles, 12 on inks and dyes, and 8 on chemical processes and products of daily life. There is a list of 55 projects. —C.M.P.

MCPHERSON, WILLIAM, HENDERSON, WILLIAM EDWARDS, and FOWLER, GEORGE WINEGAR. *Chemistry at Work.* Boston: Ginn and Company, 1938. 672 p. $1.80.

The senior authors, professors of chemistry at Ohio State University, have long been known as authors of high school and college chemistry textbooks, each widely used. However, this book is not a revision, but a completely new text, written in the vogue of today—unit organization. There are 14 units of 53 chapters. Each unit has a foreword and each chapter has a summary in question form, thought questions and optional exercises. At the end of each unit is a list of unit readings.

One has a feeling that the authors have adopted the form of the unit and not its spirit. As unit organization is the vogue today, it is often being used as a selling device rather than a teaching device. Eliminate the foreword to the units in this text and we have the old chapter organization. Chapter organization may or may not be best, but the reviewer would have preferred not to have had this lip-service to something which evidently the authors do not believe in. The reviewer believes good secondary science textbooks may be written without using unit organization and in this respect the authors have done an excellent job—so much better than their preceding text. The textual material is most comprehensive, presented attractively and as nontechnical as possible. If the liking and mastering of chemistry on the part of the students is related to the kind of text used, then this book should prove a worthy addition to present day textbooks in high school chemistry. —C.M.P.

WATERFIELD, REGINALD L. *A Hundred Years of Astronomy.* New York: The Macmillan Company, 1938. 526 p. $5.75.

In no department of science has the advancement of science been more spectacular than in the field of astronomy. In 1837 the greatest

distance measurable could be traversed by light in less than three hours. Today the greatest distance measured is 247,000,000 light years. The author attempts to give an account of these developments during the last hundred years, especially to make clear the methods, both practical and theoretical, by which the results have been achieved. The author is a member of the Council of the Royal Astronomical Society and Director of the Mars Section of the British Astronomical Society.

Altogether the book, using rather small type, is a real compendium of knowledge astronomical. The treatment is practically non-mathematical and should appeal as a valuable supplementary reader in science survey courses as well as in beginning courses in astronomy. The general reader, desiring a book that is readable and containing a wealth of astronomical facts and information, will find it in this book, written in easily recognized British style. An extensive bibliography and valuable chronological table is found at the end of the book. —C.M.P.

PICKETT, HALE. *An Analysis of Proofs and Solutions of Exercises Used in Plane Geometry Tests.* New York: Bureau of Publications, Teachers College, 1938. 120 p. $1.60.

This is a doctor's dissertation whose purpose was to: (1) prepare a revised list of geometric theorems, (2) ascertain to what extent the list of theorems of the National Committee on Mathematical Requirements has been adhered to by extramural examinations, (3) determine the algebraic techniques involved in plane geometry, and (4) find out to what extent originals offer an opportunity for methods of analysis and indirect proof. One hundred and fifty tests containing 3002 geometric exercises were analyzed.

—C.M.P.

BRADLEY, JOHN HODGDON. *Patterns of Survival.* New York: The Macmillan Company, 1938. 223 p. $2.25.

What are and what have been the patterns of structure and behavior in living things on which survival has been based? The book is an evolutionary biology that assumes some familiarity with plant and animal structure, activity and past history. He starts (p. 5) "If there is any meaning for mice or men in the restless drive of life, a billion years of living should contain it." He closes (p. 223) "If human society is ever to evolve toward some satisfactory internal adjustment, it will do so because men have broadened both their knowledge of themselves and their concept of self-interest; because the general welfare of the human species has become the standard to which all other standards are referred. . . . Self directed evolution . . . is an adventure without precedent in a billion years." The lay reader may feel at the outset that the author is rather intoxicated by his own verbosity; his vocabulary is unusual. He will get used to it and admire the profusion of ideas. The biologist may find nothing strikingly new, but he will chuckle often over the apt phrasing and adopt some of it to clarify his own thinking and expression. It is a stimulating book.

—E.R.D.

MILLIKAN, ROBERT ANDREW, GALE, HENRY GORDON, and EDWARDS, CHARLES WILLIAM. *A First Course in Physics for Colleges.* Boston: Ginn and Company. 712 p. $4.00.

This is a revision of a well-known text, made necessary by recent advances in theory such as general acceptance of the photon theory of electromagnetic radiation, the discovery of new particles and new types of radiation. In applied science equally great strides have been made in the fields of air conditioning, aviation, wire-photo transmission, high voltage X-rays, steam engineering, hydroelectric and Diesel power, television, and so on. The authors recognize, in the preface, the great need for imparting to the rising generation a better comprehension of the social significance of science. The reviewer is not quite sure to what extent the materials in the text have been modified in recognition of this demand. The authors feel that changing conditions in secondary education are resulting in greater variation in the preparation of students entering college. This condition is being met in this revision by providing "a large assortment of problems of greatly varying difficulty. . . . Since the problems furnish the key to the effective teaching of physics, much attention has therefore been paid to this feature."

—O. E. Underhill.

GRAYDON, THOMAS H. *New Laws for Natural Phenomena.* Boston: The Christopher Publishing House, 1938. 64 p. $1.50.

The author attempts, through the use of simple geometrical relationships to make a reformulation of Kepler's laws. The mathematical assumptions on which the traditional formulations are made, are attacked as being "impure" mathematics. An attempt is then made to establish relationships between planetary and atomic phenomena. ". . . the planet distances from the Sun and their relationship to each other as we move outward from Mercury to Neptune approximate the arrangement of the elements and their atomic weights according to Mendelejeff's Periodic table as we move up the range from hydrogen to uranium." On first reading, the reviewer, although somewhat skeptical, felt that possibly there was some original formulation of significance presented, but which was obscured by the confusing way in which the material was presented. Knowing something of the history of Mayer's work in the field of heat, and of its reception by the scientists in that field during his day, partly due perhaps to the fact that Mayer was obscure, and did not write in the accepted terminology of his contemporaries, one must admit the possibility that this presentation of Graydon's represents an original and signifi-

cant contribution to scientific thought. A mathematician whose opinion was asked by the reviewer feels that the objections to Kepler's laws made by Graydon are not valid, that his attitude towards units of measure is unsound, and that his substitutes for Kepler's laws are not an improvement. It seems to the reviewer that much further work will need to be done to determine whether or not the relationships brought out between chemical behavior and astronomical relationships rest on a fundamental unity of a mere juggling of numbers.

—O. E. Underhill.

VOSBURGH, WARREN C. *Introductory Qualitative Analysis.* New York: The Macmillan Company, 1918. 222 p. $2.25.

This text is a revision of an earlier edition by Cornog and Vosburgh. It is designed for a one-semester course in qualitative analysis using either macro or semi-micro schemes. The contents of the book are divided as follows: Laboratory directions—98 pages; Theory—98 pages and Appendix—10 pages.

The laboratory directions employ the conventional qualitative schemes as the author feels that the use of some of the newer schemes utilizing organic reagents would not be suitable for beginning students who have not studied organic chemistry.

The theoretical material is excellent and, extensive problem lists are included. The answers to most of the problems are included.

To this reviewer it seems that the inclusion of both macro and semi-micro laboratory directions will be somewhat confusing to the student.

—P. E. Hatfield.

MESSER, HAROLD MADISON. *An Introduction to Vertebrate Anatomy.* New York: The Macmillan Company, 1938. 406 p. $3.50.

The author has, in this volume, presented an interesting arrangement of comparative anatomy which is so organized that it can be used for either long or short courses. It is based primarily on the necturus dog fish and the cat. Other forms are included and might well be used.

It is reasonably well illustrated, usually with clear line diagrams that are easily interpreted. It has a distinct advantage over some texts in vertebrate anatomy in that it presents the whole group of vertebrates. —E. C. Harrah.

STETSON, HARLAN TRUE. *Sunspots and Their Effects.* New York: McGraw-Hill Book Company, 1937. 201 p. $2.00.

This is a brief popular treatise on what can be scientifically verified about sunspots, and many other matters that at present are only interesting speculative possibilities. An interesting feature of the book is the attitude of the author, an authority in the field, that these speculations are not to be discarded as mere fantasies of the untutored, but that there may be problems worthy of the finest research in many of the proposals of the effects of sunspots on the affairs of human beings.

Some of the problems treated are concerned with sunspots and human behavior, sunspots and radio, sunspots and business cycles, weather and sunspots, and the prediction of sunspots.

The book is extremely readable. The factual material is sound without being full of technicalities. Any layman with an interest in science can read this volume with profit and entertainment. Senior high school pupils will be delighted to find it on the shelves of the high school library. —R.K.W.

PICKWELL, GAYLE. *Weather.* Los Angeles: Hugh F. Newman and Company, 1937. 170 p. $3.00.

Without a doubt this is the most attractive book that has yet been published on weather, and the information is all seemingly accurate, too. The most unusual feature is the illustrations, fifty-nine in number. Of these, there are forty-eight 9 by 11½ inch rare photographs of clouds and other weather phenomena. No better cloud reproductions are to be found in any book.

The book is written for the general reader. Chapter headings are as follows: (1) why study weather, (2) what makes the weather, (3) signs of the weather, (4) the work of the weather, (5) what man does about the weather, and (6) learning the weather.

It is an excellent reference for general science and survey courses as well as elementary science teachers. This is a book you will not be disappointed in. —C.M.P.

CASON, CLARENCE. *90° in the Shade.* Chapel Hill: The University of North Carolina Press, 1935. 186 p. $1.00.

This book is an attempt on the part of a young Southern author to face the facts about the South. He urges other southern peoples to do likewise, for only in this way, he insists, will they ever be able to act and solve their complex social, political and economic problems arising from their geographic environment. It is so accurate, so interesting and well-written one can scarcely leave off reading when once he picks up the book. The composition style and beauty of the prose are as perfect as the southern architecture itself. He neither tried to portray, one-sidedly, the worst nor the best in the South, but actually as it really is—and so few if any writers have ever done this. His early death represents an irreparable loss to southern journalism.

In discussing the machine age in the South he says, "It is the use which mankind makes of the machines—rather than the machine itself as such—which determines whether it shall be a blessing or a curse in the South and elsewhere in the world." As I read the last page I feel it is a challenge which the author seemingly felt would, as in the past, never be accepted on the

part of his people—yet he states, "I, for one, would rather live in the South—for all of its faults—than in any other part of the world I have ever seen."

If you want to read an entertaining, keen, penetrating analysis of the South—read Cason's *90° in the Shade*—so reminiscent of the Lynds' Middletown or some of the writings of Stuart Chase. —C.M.P.

MORGAN, ALFRED. *Things a Boy Can Do With Electricity*. New York: Charles Scribner's Sons, 1938. 243 p. $2.00.

Elementary, practical books on electricity are always welcome. In this field there is a real lack of simple, useful material. This book will appeal to elementary science, general science and physics teachers as well as to junior high and senior high school pupils. It is an excellent supplementary book for the science book shelf.

Many appealing, instructive, amusing experiments are included in this book, so delightfully written and pertinently illustrated. There are about one hundred and fifty illustrations. The vocabulary is as non-technical as possible.

The chapter headings are as follows: (1) Becoming Acquainted With Electricity, (2) A Curious Mineral Which Leads To Adventures With Magnetism, (3) Building and Using Electric Batteries, (4) Discovering Things Which Electricity Will Do, (5) Making Electricity Show Its Muscle, (6) Fun With a Spark Coil, (7) Electrochemistry, The Partnership of Electricity and Chemistry, (8) Exploring With Microphones and Telephone Receivers, (9) Electric "Eyes," (10) Alternating Currents, and (11) Things You Should Know About Tools, Wires, Glass and Other Materials. One hundred and twenty five theorems were studied. Algebra is of great importance in plane geometry. C.M.P.

HEGNER, ROBERT. *Big Fleas Have Little Fleas*. Baltimore: The Williams and Wilkins Company, 1938. 285 p. $3.00.

To find a scientific treatise with humorous cartoons and frequent bits of doggerel in it is unusual. Such may induce lay readers to tackle a book that otherwise might appear forbiddingly scientific. "Who's Who Among the Protozoa" (the sub-title) is also lightened by delightful travel tales, descriptions of the author's journeys in Asia and South America while on the trail of these minute but marvellous creatures.

Not only does the book describe many of the important protozoa, giving also their life histories and some account of their discovery, but it discusses some questions of general biological interest such as the evolution of the parasitic protozoa. The experiments reported on the relation of the intestinal protozoa of man to diet and to specific curatives appeal to the general reader but especially to the physician. Indeed much of the book will interest medical men particularly for it treats of the parasitic protozoa that cause malaria, sleeping sickness, chagas, amebiasis, kali-azar etc. The whole volume is highly instructive and no less so because it is entertaining. Put on the shelves of the public or high school library it will soon show the wear of frequent use. —E.R.D.

KILANDER, H. F. *Kilander Health Knowledge Test for High School Senior and College Freshmen*. East Orange, N. J.: The Author, Panzer College of Physical Education, 1936. $1.40 per set of 25, $4.80 per set of 100.

This test consists of 100 multiple-choice questions dealing with health knowledge in the fields of Nutrition, Communicable Diseases, Sanitation, Safety and First Aid, Social and Mental Health, including common errors and superstitions in these fields. Time required is 40 minutes. Such a test can be used for diagnostic purposes and for student motivation. —L.M.S.

BUCHANAN, ESTELLE D., and BUCHANAN, ROBERT EARLE. *Bacteriology for Students in General and Household Science*. New York: The Macmillan Company, 1938. 548 p. $3.50.

Again the authors have presented another very fine edition of their standard text in bacteriology. Much of the book has been rewritten and added to in many places. It has been simplified in many ways, especially in bacteria, yeast, and molds.

In addition to the simplification of these chapters, they have been much expanded. The keys to the family in general have been taken out of the body of the text and placed in an appendix.

The new views concerning bacteriology are presented in this text. A complete new chapter has been added on the characters of viruses and bacteriophages.

This book is well adapted to an introductory course in bacteriology in liberal arts colleges. —E. C. Harrah.

BEST, CHARLES HERBERT, and TAYLOR, NORMAN BURKE. *The Living Body. A Text in Human Physiology*. New York: Henry Holt and Company, 1938. 563 p. $3.60.

Another volume is presented by these well-known authors to those who teach physiology. The book is prepared for an elementary course and deals with the actions and reactions of the physical and chemical changes occurring in the human body.

The data gained from the experiments upon animals are used to give the students the facts of certain experiments in physiology.

While the authors assume that the readers will have had some knowledge in physics and chemistry, the book is not too difficult in this respect, and I believe can be handled by students with only an elementary knowledge of these fields.

The arrangement by the authors is one that seems logical and tends to stimulate interest in the readers. The chapters are built first on the functions that exist, then the experimental evidence which verifies the interpretation. This is

usually followed by applications in our every day living.

The book is especially desirable for beginners in the physiology and as a reference book for those seeking some fundamental knowledge of physiology in biological courses.

He also has here an excellent chapter on the functions of reproduction. This section of human physiology has been omitted too long from most of our textbooks. —E. C. Harrah.

FULOP-MILLER, RENE. *Triumph Over Pain.* Indianapolis: The Bobbs-Merrill Company, 1938. 438 p. $3.50.

This Story of Anesthesia (the sub-title) by its Hungarian author is translated by Eden and Cedar Paul. After early chapters on the discovery of ether, laughing gas, morphine and other means of producing insensibility to pain, the bulk of the book is devoted to a detailed account of the lives and activities of the men who introduced anesthesia in operative surgery —Dr. Crawford W. Long of Georgia, Horace Wells, dentist, of Hartford, Conn., his partner, William Morton of Boston and Dr. Charles T. Jackson, consulting chemist. The rivalry of these men for the honor and the financial returns attaching to their discoveries is rather disgusting reading. It landed Jackson in the insane asylum, killed Morton by apoplexy in a paroxysm of rage, brought poverty and unhappiness to the others. The rivalry continues after their deaths. A statue of Wells in Hartford, Conn., bears an inscription claiming for him the discovery of the use of anesthesia for such a purpose. A statue of Long in Washington, D. C., makes a similar claim. While Massachusetts names Morton second on its list of its greatest sons because he was the discoverer.

The author avowedly tries to make the story dramatic. In the reviewer's estimation he overdoes it. The 5-page chronological summary at the close of the book and the 16-page bibliography that documents the facts seem to him the best parts of the book. —E.R.D.

FARRINGTON, EDWARD I. *The Gardener's Omnibus.* Boston: Hale, Cushman and Flint, 1938. 886 p. $3.75.

This book was published under the auspices of the Massachusetts Horticultural Society. The editor-in-chief is secretary of the Society and editor of Horticulture. The blurb says this is the most complete and practical garden book ever published. Emphasis has been placed on the "how" as well as the "what" in gardening. Illustrations are found almost on every page—there being a total of over 600. And these illustrations—all photographs—are usually good.

A few of the headings of the thirty-nine chapters indicate the variety of topics discussed: (1) gardens and garden features, (2) rock gardens and what to grow in them, (3) perennials and biennials, (4) annual flowers, old and new, (5) herbs and herb gardens, (6) roses and their care, (7) pools and aquatic plants, (8) ornamental shrubs in summer and winter, (9) the art of photographing flowers, and (10) the garden calendar.

Biology and elementary science teachers and all general readers having flower or vegetable gardens will be interested in this appealing book. —C.M.P.